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ABSTRACT

Most people recognize science education as an essential part of the school curriculum and the education of students growing up in a technologial modern world. School science does not thrive in isolation. It should be influenced by other curriculum areas and in turn it should influence them. However, the subject, in some instances, has been isolated due to emphasis placed on its unique and distinctive features. This has made it difficult for many students to gain a sense of pleasure and excitement from its study. This publication attempts to show science education in the context of the whole school curriculum. It describes staff members' attempts to change their approach to science teaching which will subsequently have an effect upon the rest of the school and community. The book is divided into sections which present: (1) a review of achievements and shortcomings; (2) governors' views; (3) the review of the secondary science curriculum; (4) the school's plan of action; (5) conclusions; and (6) a glossary. Appendices include policy statements, and a summary of publications in the Better Science series. (RT)

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SECONDARY SCIENCE CURRICULUM REVIEW

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BETTER SCIENCE:
Making it happen

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SECONDARY SCIENCE CURRICULUM REVIEW

SSCR

BETTER SCIENCE:
Making it happen

Edited by Maureen O'Connor

Heinemann Educational Books/Association for Science Education
for the School Curriculum Development Committee

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Foreword

This book is intended to achieve two purposes. It is, first of all, a publication which seeks to inform readers of the principal aims of the Secondary Science Curriculum Review, and to convey the major outcomes of the process of development which constituted Phase 2 of the Review from 1983 to 1986. The readership we address is purposefully a wide one, embracing all who have an interest in the process of education in general, and in science education in particular.

The second purpose in the production of this book arises from an acceptance that the process of change in any part of the secondary school curriculum is certain to be a very complex activity, involving a range of agents and agencies. Science education is no exception to this, and it is acknowledged that among those agents will be many without a first-hand knowledge of science itself. For that reason it was felt to be important to invite a group of people, some of whom had not been centrally involved in the work of the Review, to generate a publication which would both point to the complexity of the nature of innovation and also offer some ideas for achieving change. The focus identified as an appropriate vehicle by which those topics may be discussed most appropriately for a readership which is intended to be wide is the governing body of a secondary school. The characters portrayed there are fictitious, but the issues raised within the governors' meetings, consequent on a review of the school science department, are real. By describing the range of interests vested in the members of the governing body, it is intended that the narrative style employed will stimulate thought in the minds of individual readers and suggest potential activities for groups engaged in initial and post experience training.

The book owes a great deal to the expertise of George Walker, who accepted the task of leading the group during its residential writing phase, and to Maureen O'Connor for her journalistic skills deployed both throughout the creation of the work and in its completion. Thanks are properly due, however, to the whole community of the SSCR. Their work provides the reason and the justification for the writing of this book. That community now wishes to join with the wider community of teachers, parents, LEA officials, government officials, higher education, the world of work, and the students themselves, in creating the means whereby changes can be made in the improvement of science teaching in the secondary schools, for the benefit of all.

Jeff Thompson
Chairman
SSCR Steering Committee

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The ideas presented in this book are not only the result of the work of SSCR groups. Their production has also relied on considerable discussion in, and on the collective wisdom of, the SSCR Central Team:

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Introduction

Few people would deny the importance of science education in the school curriculum. Most would regard it as an essential part of the education of all young people growing up in the increasingly complex and technological modern world. But school science does not exist in isolation. It is part of the whole, balanced experience which should be provided by a unified and coherent school curriculum. Science in schools should be influenced by other areas of the curriculum and in turn should influence them. Moreover, in the secondary school, it must seek to build upon the experiences that have been a natural part of an exciting primary school curriculum.

Fig. 1 Science – a natural part of an exciting primary school curriculum.

Too often in secondary schools, science has seemed to students, parents and teachers to be quite separate from the rest of the curriculum and from the realities of everyday life: it has often seemed remote, clinical and inaccessible. The unique and distinctive features of science have, perhaps, been emphasised to such a degree that they have served to isolate the subject,

making it difficult for all but a minority of students to gain much pleasure or satisfaction from its study.

This book seeks to show science education in the context of the whole school curriculum. It describes how the staff of a typical science department, in a typical comprehensive school become dissatisfied with their work and seek to change their whole approach to science teaching. Understandably, it soon becomes apparent that the proposed changes will affect not only the science department but also the rest of the school, and, indeed, the community of which the school is a part.

In the first section of the book, the science department at Sevenelms School, encouraged by the head teacher's review policy and responding to both the curricular implications of the 1986 Education Act, examines its achievements and shortcomings in the light of current local and national recommendations about science education. In a comprehensive review document, the department proposes far-reaching changes.

However, school departments cannot change unilaterally, particularly if they are high-spending science departments. So how acceptable are the proposed changes to the other interest groups, both within and outside Sevenelms? In the second section of the book, a number of school governors, representing a range of viewpoints, comment on the science department's proposals and try to influence the precise direction of change.

The third section explains the recommendations of the Secondary Science Curriculum Review. It helps the reader to examine the proposals of the head of science at Sevenelms in the context of a nationally-funded appraisal of science education which has focussed a wide range of opinion on the challenge of making science more accessible to all young people.

In the final section, some implications of the Sevenelms proposals are examined. How can a school change what it has been doing for a very long time? What are the main agents for change and how does a school gain access to them? How can an individual school implement easily the recommendations of a nationally-organised curriculum review, given all the constraints on time, personnel and cash which face the average head teacher and staff?

At the end of the book is a Glossary which defines important terms used in the text.

ONE

The science review at Sevenelms School

The science department of Sevenelms Comprehensive School has undertaken an extensive review of science at the school. The department met on six occasions during the review period and most members of the department attended a weekend writing conference towards the end of the summer term. This important meeting was funded by the local education authority as part of its in-service training provision.

The departmental review was undertaken as part of the five-yearly review policy adopted by the head teacher and the Academic Board in July 1985 and took place alongside reviews of modern languages and humanities teaching.

While these reviews were being carried out, the Education (No. 2) Act 1986 was passed. This Act, which is being phased in from September 1987, applies to all state schools and places particular responsibilities on local education authorities, school governing bodies and head teachers in respect of the curriculum in schools such as Sevenelms. Under the Act, local education authorities must state and publish their curricular policies. School governors are obliged to consider these policies and determine their own aims for the curriculum of the school, saying how (if at all) they believe the authority's policy should be modified in relation to their school. Departmental reviews are an important means whereby the local head teacher and teaching staff can help the governing body to reach their conclusions on these questions, and review them as necessary. The new Act also gives the head teachers specific responsibilities for the determination, organisation and delivery of the curriculum, and the departmental review is one mechanism whereby the head teacher can discharge this responsibility.

In undertaking its review, the department has made use of a series of interviews with students carried out in the spring term, a number of visits by the science adviser and members of his advisory teacher team, and a number of valuable consultations with staff in other subject areas at Sevenelms School. The department was assisted by Mrs Jackson, Head of Science at Broadway School, who joined the initial planning meeting and the summer term writing weekend. What follows is a report of this review.

Science at Sevenelms Comprehensive School
A departmental report prepared for the head teacher and the governing body in January 1987.

Introduction

This departmental review has taken into account the Governors' statement that the curricular aims of the school should follow those produced by the local education authority. Their statement has been influenced by discussions of the implications of the Department of Education and Science document, *Science 5-16: A statement of policy* and the publications of the Assessment of Performance Unit, the Secondary Science Curriculum Review and the Children's Learning in Science Project. It has also taken into account the introduction, in September 1986, of the General Certificate of Secondary Education (GCSE) syllabuses.

The aims of the department

The science department is fully committed to the following aims:

1 Every young person in the school, regardless of gender, ethnic origin, class or religious background, is entitled to a basic education through science as part of their curriculum up to the age of 16 years.

Fig. 2 The department will present a picture of science that is intellectually challenging, stimulating, exciting and relevant

2 Within this minimum entitlement, the department will present a picture of science that is intellectually challenging, stimulating, exciting, and relevant to the students' personal experience and to their present and adult lives.

3 The minimum entitlement for all students will represent a broad and balanced view of science, that is to say, a view of science which includes a balanced mix of biology, chemistry and physics, and also some astronomy, earth sciences, electronics and technology. This view should also show the links and relationships between science, technology and society. The image of science we create will enable young people to appreciate that science is a human activity that takes place in a social context and thus reflects particular social, cultural and historical norms and values.

4 In defining the content of the curriculum for all students, care must be taken to ensure that work in science is effectively coordinated with the rest of the school curriculum, so students are provided with an overall programme of studies which is coherent, balanced and appropriate to their needs and ambitions.

5 A major aim of the department is to ensure that, on completion of their studies at 16, all pupils have had access to a body of useful and up-to-date knowledge and a wide range of useful skills. They should also be in a position to further their understanding of, and interest in, science and technology in a self-directed way in further, higher and continuing education.

6 In addition to providing a minimum entitlement for all pupils, the department must ensure that provision is made for some students to proceed further with their studies in order to satisfy fully their levels of motivation and ability.

7 Finally, the department will seek to ensure that all teaching and learning activites have appropriate resources of equipment, books and materials. The department will ensure that all learning and teaching activities are properly assessed. Formative assessment, that is assessment carried out during the course of a unit of work to monitor the progress of individual students, is considered an important way of enhancing educational opportunity. We also consider student self-assessment to be an important component of departmental provision.

The outcomes of the departmental review

The current science curriculum offered to students

Year	Course	Number of groups	Group size	Ability range	Periods /40
1	Combined Science	6	30	Mixed	4
2	Combined Science	6	30	Mixed	4
3	Circus course*	6	30	Banded	6
4	GCSE Biology	2	25	Setted	5
	GCSE Chemistry	1	10	Setted	5
	GCSE Physics	2	28	Setted	5
	GCSE Human Biology	2	28	Setted	4
	GCSE Electronics (Mode 3)	1	15	Setted	4
	GCSE Science at Work	2	20	Setted	4
5	As Year 4 with similar numbers				
6	A level Biology	1	10	Setted	8
	A level Chemistry	1	2	Setted	8
	A level Physics	1	7	Setted	8
	CEE Science and Society	1	15	Mixed	6
	CEE Useful Science	1	10	Mixed	6
7	A level Biology	1	12	Setted	8
	A level Chemistry	1	4	Setted	8
	A level Physics	1	9	Setted	8

*The circus course consists of one-term units of biology, chemistry and physics, each taught by specialist staff.

Current departmental staffing

The current staffing of the science department is set out in the following table.

Post	Scale	Teaching periods/40
Head of science department (Physics)	4	29
Head of Chemistry	3	31
Head of Biology	3	31
i/c lower school science	2	33
i/c resources	2	33
Assistant teacher	1	35
Assistant teacher	1	35
Computer studies department	(3)	8

All the above staff are full-time members of the science department with the exception of Mr Jones who is a member of the computer studies department currently teaching fourth and fifth year electronics.

All members of the department are science graduates and have postgraduate teaching qualifications. Two staff have Masters degrees and one a PhD. Two are certificated to use radioactive materials and to operate a laser. Between us we have attended a range of local education authority and national courses and conferences, on a variety of educational topics. One junior member of the department is an active participant in a local Secondary Science Curriculum Review working group. All members of the department are members of the Association for Science Education and the Head of Biology is a Fellow of the Linnean Society.

***Fig. 3** Our general concerns include making special provision for girls*

We feel we all have several general in-service needs and a number of staff have identified personal professional development needs. Our general concerns include making special provison for girls and for students with different cultural and ethnic backgrounds. We would all benefit from in-service training that focusses on the development of alternative teaching strategies, and we have a special interest in the problems of retraining and continuing education in the context of teaching outside areas of initial subject strength. The department is worried by the demands of new assessment strategies, particularly for GCSE, and has little experience of setting, marking or moderating course work. We are not well qualified to assess practical skills or to take on the issues raised by profiles of performance.

While two members of the department have gained some experience in educational drama (through a national competition), others feel that some of the new teaching methods being suggested (e.g. role play) are very daunting. We would like specific in-service provision in the management of technological problem-solving, computer assisted learning, group discussions and extended project work. We would also like to develop further teaching materials for our work in Years 1 to 3 and one member of the department has expressed a keen interest in exploring the full implications of resource-based learning.

Critique of the science curriculum currently offered

YEARS 1 AND 2

The department is reasonably happy with the first and second year Combined Science course that was developed some six years ago. The course is based essentially on the Nuffield course, with some variations developed at Sevenelms. The course utilises a range of well-produced worksheets linked to standard experiments, and we have introduced a small scale investigation topic in each term. At the same time, the department acknowledges a number of problems with the course.

Firstly, we are not taking full advantage of the fact that an increasing number of first year students are entering the school with a rich experience of science from their primary school. The pattern of the first year course assumes little or no knowledge of science. Thus, for some of our students, Year 1 is less exciting and stimulating than it might be. This problem is well illustrated by a comment from Sally Kahn (form 1R).

> *At my first school we were using a BBC computer to control some models we had made, and also used it to count things for us. At this school we never use a computer in science lessons, which seems a pity.*

Secondly, we do notice that the level of motivation of many students begins to decline in Year 2 and a lack of excitement in much of the work becomes apparent. The department feels that this is probably being caused by the rather traditional experimental work (e.g. circuit boards) and our heavy reliance on pupils working in pairs. The small-scale investigations have improved performance significantly and we need to develop this work further. Essentially, we need to make the science activities in Years 1 and 2 an extension of good primary school practice.

Our third problem is in catering effectively for the significant number of students in the lower school who have learning difficulties. While the mixed ability provision appears to work well for the average and above average ability students, others are less well catered for.

Finally, we are not convinced that we have established a proper balance between content and process in Years 1 and 2. The scheme of work is over-dominated by content and only very basic experimental skills are covered. What we fail to bring out, in spite of the mini-investigations, is a systematic use of problem-solving skills, study skills, and higher level investigatory skills.

YEAR 3

With one exception, the whole department has registered a strong concern with respect to the organisation and management of science studies in Year 3. The circus is unpopular with staff, who find a single term too short a period to really get to know students and who find the business of repeating their unit three times very tedious. Two-thirds of the students cannot take the Christmas examination in two of their science subjects, and one-third of the students have to finalise their option choices before they take one of their subject units. Many of the students expressed a strong dislike of the circus when interviewed in Year 4. A typical response was that of Ramanda Johnson (form 4T):

> *I found science last year very confusing. I did chemistry, then biology and finally physics and because I hadn't done physics I opted for biology and chemistry. Actually I found the physics unit really great – good fun, and very useful. Much more interesting than chemistry – all those molecules and things. Also we never got to know the teachers and by the time we had settled down to do the unit it was all over.*

We are also concerned with the serious progression and continuity problems created by the circus arrangement, the problems of keeping track of student progress, and the strong evidence of a rapid decline in motivation amongst the average and below average pupils. As Trevor Robson (4C) put it:

> *Year 3 science was all bits, and deadly boring bits at that. I got really switched off by it.*

The Head of Chemistry expressed his opinion slightly differently:

> *The Year 3 circus is all clowning about with no precision high-wire act to be seen.*

In many ways the circus has created more problems than did the system of separate double periods of biology, chemistry and physics that it replaced in 1985.

YEARS 4 AND 5

The department is pleased with the shift in emphasis created by the introduction of GCSE but is still worried by several aspects of the work in the examination years. The problems of subject choice are still present, and the small groups in chemistry are causing great concern. Youngsters are still making

their choice of options for examination when they are not sufficiently familiar with the separate science subjects. Also there remains a heavy preponderance of boys in the physics and electronics sets and girls in biology and human biology.

A further problem that is now becoming apparent is the marked increase in course work assessment and in the practical assessment of skills and processes under the GCSE regulations. The new GCSE syllabuses are still far too overloaded to allow much time for continuous assessment, and as a department we still lack many of the skills needed. (It will be remembered that our GCSE in-service training programme was a very unsatisfactory one.) The department feels the need for a more balanced approach to Years 4 and 5, a greater emphasis on skills and processes, and a radical attack on the assessment problems.

The other fourth and fifth year courses [electronics, human biology and Science at Work] are popular with our students, but do present problems. Both electronics and human biology are too narrow, over descriptive, lacking in process objectives, and weak in terms of cross-curricular links. This is a major problem for average and below average students, for whom one of these subjects may represent the total science involvement.

Although the Science at Work course is very popular with many of the boys, it has not attracted large numbers of girls, and the teachers working on this course fully acknowledge that many students are underachieving. The course needs rethinking and modernising.

(As the context of this publication is science 11-16, the detailed critique of work in Years 6 and 7 is not presented here.)

Other aspects of departmental performance

In this section of the review we comment on our progress under ten headings, some of which were taken from the DES policy statement, *Science 5-16*. The remainder relate to specific aspects of whole school policy.

1 Breadth: a broad range of science studies
We are aware that the courses we follow in Years 1–3 are not particularly broad – for example, the only earth science that is covered is some work on the extraction of ores in Year 2. The health education aspects we cover are very brief and limited. Admittedly we now offer electronics in Years 4 and 5, but we are aware that we have little to offer, for instance, in the way of astronomy, biotechnology or computer science.

2 Balance: a balance between the sciences

The three main sciences are well balanced in Years 1 to 3, and the circus arrangement in Year 3 allows all the youngsters to have some experience of biology, chemistry and physics. The circus does have the drawback that some school terms are longer than others, and the summer term is always disrupted in one way or another.

Work in Years 4 and 5, however, is seriously imbalanced. At the end of the third year, students choose the subjects they wish to study in the next two years. Only a small percentage of students choose to do two sciences and only a handful are doing three. The majority of those who leave at sixteen have studied only one science.

3 Continuity: a continuous programme of science from primary school onwards

We have particular problems in our catchment area trying to take account of the work that our students do at primary school. We have already commented on the implications of this and the need to build on the primary school foundation work more effectively (see page 8).

In Years 1 to 3 the continuity is fair. Groups retain the same teacher for Years 1 and 2, and work is based upon a clearly defined scheme. Year 3 is a problem because the circus arrangement does not really allow us to provide the continuity we would like. Some members of the department do not like teaching three separate groups in a year, though others welcome the possiblity of meeting a large number of third year students, if only for a term at a time.

We are worried that the number of students opting to take science at A level is dwindling, and that we are losing many to the local colleges. We are unsure how best to provide for continuity after 16 and would appreciate the advice of the Academic Board on this.

4 Progression: ensuring progressively deeper understanding

The integrated science scheme in Years 1 and 2 is good for it allows youngsters to progress through a series of topics which are organised within overall themes. We are disappointed with the Year 3 work in that the circus arrangement does not allow us to form all the connections and links we would like. The topics we cover in each term's work are really quite separate and unconnected.

We are aware that the students themselves do not always see things in the coherent way that the course and the teaching intends. John Devereux (3C), for instance, said:

> *One minute we seem to be doing paper chromatography and then the next we're cutting up a bull's eye. We skip from one thing to the next and we never know where we are.*

The situation is different in Years 4 and 5 in that chemistry and biology

seem to provide clear coherence and progression through the work. Physics, on the other hand, seems to be treated as a series of fairly separate topics. Some youngsters have complained that the course seems to move backwards and forwards between chapters of the textbook without any clear order or connection. For example, the work on heat is not connected either to the work on light or to that on energy.

5 Relevance: drawing on everyday experience
We are very concerned that little of the work we do is seen as relevant to the students' own experience and to society in general. Youngsters see the electronics course in Years 4 and 5 as the most relevant of our courses (all the students in this group are boys). However, the majority of our science courses contain very few instances of the application of science in national or local industry. Some of the youngsters asked why we did not do microwave ovens when we looked at waves in Year 3 physics as they wanted to know what happened inside the 'black box'. They have said they would like to do much more about the skin in biology – about skin care, cosmetics and hygiene, as well as skin grafts in a hospital burns unit.

6 Differentiation: a curriculum suited to all students
We are pleased with the way we have managed to cater for the wide ability range in Years 1-3. We are grateful for the help we have received from the English and special needs departments in reshaping our worksheets and for the book-boxes we keep in the department. However, our textbooks are out of date and unsuitable for most of the youngsters. The banding system in Year 3 means we can cater for the different ability groups, except that the bands are still fairly wide and few staff enjoy taking the Green Band children on Friday afternoons. We are pleased with some of the extension workcards and projects that we have developed for Years 1 and 2. The Science at Work course is very popular and seems to provide just the right level of work for many of the youngsters who opt for it, although some of the more able students may be underachieving and need to be provided with more extension work.

7 Equal opportunities
The problems we have are similar to those in other local schools. Our work in Years 1–3 is very much biased towards the interests of the boys. Girls who opt out of science (especially physics) in Year 4 say that it is boring, uninteresting and 'nothing to do with them'. As Cheryl Andrews (4H) said:

> *Physics seems to be all about rockets, cars and electricity. There's nothing about medical science or about people and everyday lives. I'd rather do human biology if I've got to do a science.*

Her feelings are echoed by many other girls and the pattern is reflected in the numbers opting to study science in Years 4 and 5. We are unsure how

best to proceed in this area and would welcome specific advice and in-service training. If we move to a system that requires all girls to do science, including some physics, in Years 4 and 5, then we are going to have to change the syllabus drastically to keep them interested. In particular, we would have to change the textbooks and many of the worksheets we use because they are orientated towards the interests of boys.

We have begun to make some changes to take account of the cultural diversity in the school. The work we do on nutrition in biology now reflects a variety of diets and culinary customs. We are also very aware of different religious beliefs concerning sex education, though we can only cope by allowing youngsters to withdraw from the lesson if their parents are unhappy about these parts of the syllabus. We are worried by many of the images presented in biology textbooks, particularly where they deal with issues of race. The pictures shown may be crude stereotypes and many have been defaced and written over in abusive and offensive language. We have not yet managed to include a range of scientific applications from around the world.

We are pleased that we have managed to retain full mixed ability in Years 1 and 2 and that we do not have youngsters extracted for remedial work. We have initiated a new policy of team teaching with members of the special needs department which is designed to help students who are struggling with basic literacy and numeracy. We are attempting to make proper provision for both of the youngsters in the school who are statemented and for David Smith (3R), who is physically handicapped.

8 Numeracy

We are disappointed with our own progress in highlighting and promoting numeracy through science. We know that science work is not well matched to work in the maths department, and we often require skills with which the youngsters are not equipped. For example, the geometrical optics and circuit work in Year 3 demands mathematical skills that are not covered until Year 4 in maths. We have had to drop some parts of the first year work because of mathematical problems, and youngsters in Year 2 traditionally find it difficult to calculate power, work, pressure, and surface area to volume ratios.

9 Language

The textbooks we use are still a major problem as far as readability is concerned and a large number of class sets need to be replaced. As mentioned earlier, we have been systematically screening the reading books and worksheets with members of the special needs department. We have good links with the English department and they have recently tried a 'Season of Science Fiction' where second year students have explored such books as *Antigrav* by Fisk. We are pleased with the language work we have been achieving. We have evidence of some excellent creative writing and

poetry on themes related to science. We are also using the multilingual health and safety regulations bought from the Inner London Education Authority. There is much more that we could do, in particular, encouraging discussion in small groups and by the whole class and trying out some educational drama.

10 Links with other departments

We have already mentioned a number of initiatives with other departments, for instance with English and special needs. We do have discussions with the maths department but would like to do more. Our links with CDT and home economics are disappointing, in fact non-existent, nor do we have good liaison with geography or geology. The 'Useful Science' group have done some good work in photography with the art department and some of the Science at Work groups have been helping the drama department with the stage lighting. We recently had a very successful joint outing with the history department to the local industrial archeology park.

Departmental curriculum development priorities

After due consideration, and in the light of advice given, the department wishes to identify areas of development over the next few years as follows.

Years 1 to 3

The department wishes, as a matter of extreme urgency, to develop a three year integrated science programme that meets the broad educational aims set out at the start of this report and also addresses the problems and weaknesses identified above.

The new course would start with a three week diagnostic programme, designed to establish what a student's abilities are on entry to secondary school, using a range of performance criteria drawn from the work of the Assessment of Performance Unit. This programme would not, however, involve formal examinations.

Course materials would be designed so that common tasks were provided at three distinct levels. These would be appropriate for first year students starting with good, average or poor backgrounds in primary science studies. Group organisation within the mixed ability framework would ensure that pupils with different backgrounds could help each other. The course would consist of a sequence of short units, each involving problem-solving tasks, investigations and the opportunity to use new knowledge and to apply and further develop skills. Due attention would be paid to equal opportunity issues, language, numeracy and study skills. Each unit would involve self- and peer-assessment opportunities and the completion of a joint teacher/student performance profile.

Fig. 4 The course would consist of a sequence of short units each involving problem solving tasks

During the third year a clear element of subject differentiation would be incorporated into each unit in order to sharpen up the distinctions between the life sciences and the physical sciences.

It is intended that this development work should be initiated immediately, with the intention of introducing the revised scheme for the first year students in September 1988.

Years 4 and 5
We see the changes here as taking place in two stages.

In stage one (1988 onwards), we would wish to replace the present curriculum with two new basic options, a double science course and a modular course. This decision was taken after reviewing the possible curriculum options which we see to be integrated, combined, coordinated or modular courses.

The new double science course will occupy eight periods a week and lead to a double GCSE award (Biological Sciences and Physical Sciences in 1990). Suitable courses have been developed in the context of GCSE and the Secondary Science Curriculum Review. A course of this nature is seen as a natural progression from the revised Year 1 to 3 course and would seek to capitalise fully on the basic objectives set out above. Students would be banded

so as to create six teaching groups able to follow the double science course (approximately 120 students). The remaining sixty students would be allocated to a Mode 3 Modular Science course leading to a single GCSE award or a school certificate of performance. Again, suitable course outlines and resources are available from the publications of the Secondary Science Curriculum Review.

In the longer term the department plans to develop a unified modular course (leading to single or double GCSE certificates) for all fourth and fifth year students. It is likely that we will be able to make this course available from September 1990 onwards.

Other developments

Apart from the developments in assessment and teaching methods dealt with later in this report, the others we hope to put in train are to do with special educational needs and cross-curricular links.

As regards special educational needs, the science department would wish to develop teaching links with colleagues in the special needs department in an effort to raise the level of performance of many students. Specific areas to be addressed include English as a second language, statemented students and students with physical handicaps.

In the area of cross-curricular links, we hope to build on our strengths, greatly improve our currently ineffectual mathematics and numeracy work, and enhance links with home economics and CDT.

The curricular implications of our short term and longer term development priorities are set out in the following tables.

Curriculum pattern in the short term 1988-90

Year	Syllabus	Number of groups	Group size	Ability range	Periods /40
1 }		9	20	Mixed	4
2 }	Integrated science	9	20	Mixed	4
3 }		9	20	Mixed	6
4	Double science	6	20	Banded	8
	Modular science	3	20	Banded	4
5	Double science	6	20	Banded	8
	Modular science	3	20	Banded	4

Curriculum pattern in the longer term 1990-92

Year	Syllabus	Number of groups	Group size	Ability range	Periods /40
1	Integrated science	9	20	Mixed	4
2	Integrated science	9	20	Mixed	4
3	Integrated science	9	20	Mixed	6
4	Modular science (Double Certificate)	9	20	Mixed	8
5	Modular science (Double Certificate)	9	20	Mixed	8

Teaching methods

As part of the review the department made a systematic check on the range of teaching methods used by staff. For this analysis we used the list given in the DES policy statement, *Science 5-16*, with a few additions. For each method we used the categories 'very frequently', 'often', 'sometimes', 'seldom' and 'not at all'. The results of the analysis are shown below.

Analysis of teaching methods

Method	Years 1–3	Years 4 and 5
Problem solving	sometimes	seldom
Investigations	often	sometimes
Practical work	very frequently	often
Field work	sometimes	seldom
Exposition	often	very frequently
Demonstration	often	very frequently
Discussion	sometimes	seldom
Role-play	not at all	not at all
Games and simulations	sometimes	seldom
Radio, video, TV	sometimes	sometimes
Computer-assisted learning	sometimes	seldom
Individualised learning	seldom	not at all
Small group work	often	sometimes

It will be noted that the department uses a fairly restricted range of teaching methods which is dominated by experimental work, exposition and demonstrations. The recent changes in our approach to science in the first two years are reflected in an increasing use of investigations and small group work, which are not found in the upper school. The department is very concerned at the sparse use of field work, individualised learning, and computer-assisted

learning. Finally, we are clearly failing to make effective use of discussion methods and new techniques like role-play, games and simulations.

Fig. 5 The recent changes in our approach to science are reflected in an increasing use of investigations and small group work, not found in the upper school

While the department is keen to remedy this over-reliance on traditional teaching strategies, there is a clear need for systematic in-service training in this area. Some of this can be provided within the school through joint work with other departments, but we recognise that the school as a whole lacks expertise in individualised and computer-assisted learning.

Assessment

In reviewing its approach to assessment, the science department is conscious that the Academic Board has established a school working party to review the whole school policy on this subject. Nevertheless, the department has examined its present approach and wants to suggest a number of significant changes.

Currently, assessment takes the form of marking the students' course work and homework books for content and effort on a letter grade system. The department follows the current marking and homework policies of the school, and we are very satisfied with the consistency and care with which work is marked. However, we are not satisfied with the letter grade system which

means that much of our marking is very routine. In addition, most staff make frequent use of short pen and paper tests.

Again in accordance with school policy, the department sets objective test examinations at the end of Years 1, 2 and 4, and, in order to link examination results to the option choice system, at the end of the Christmas term of Year 3. The majority of fifth year science students are, of course, also assessed through appropriate mock and public examinations.

In reviewing this policy the department wishes to express its long standing reservations on the end of year examinations and the extensive use of objective tests. We feel that these examinations tend to emphasise knowledge-based objectives and are inappropriate for checking process- and skill-related objectives. We also find it difficult to use these examinations in a formative manner. The department would like to develop the new methods of assessment that are incorporated in the GCSE and to implement them as standard practice from Year 1 onwards. As suggested earlier in this report (page 14), we also want to link formative assessment more closely to specific units and modules of work rather than to year-long blocks of work. Finally, the department wishes to explore the possibility of introducing a 'Profile of Science Development' which would be held by every student as a cumulative record of her or his progress in science throughout the school. We regard it as essential that the students see their profile as a self-assessment record completed in association with the teaching staff. We feel that such a policy would be consistent with the proposals made by the DES in their publication *Examinations at 16+: A statement of policy* (HMSO 1982).

In making these radical proposals the department accepts that it will have to carry a heavy load of development work over the next few years. In a sense the introduction of the GCSE makes some of this inevitable, but we feel that a new approach to assessment will do a great deal to raise the standard of achievement across the whole ability range at Sevenelms.

Finally, we note that after careful discussion the weight of opinion in the science department was strongly against the introduction of graded assessment. We were not happy with any of the schemes currently available.

Non-teaching resources

The science department is sited in a suite of six main laboratories and two A level laboratories. Three of the main laboratories are equipped for the separate sciences (biology, chemistry and physics) and the other three are equipped for general use. The two small laboratories have also been converted to general use (sixth form small group work, the electronics course and GCSE chemistry

teaching). The two small laboratories and one of the larger ones have become rather dilapidated. The laboratories are in pairs on three separate floors of the main school building and each pair is serviced by a preparation room. The animal house and greenhouse are both situated on the roof above the biology laboratory.

These physical resources are barely adequate for the science we teach at the moment. We are agreed that changes in our science courses will require the refurbishment and redesign of the laboratories and preparation rooms in order to create the greater flexibility that the new teaching methods will require. The department has produced detailed plans for removing fixed island benches, relocating services and converting all specialist laboratories into multi-purpose rooms. We would also like to convert two classrooms on the second floor, which are not in heavy use at present, into a science resource and study area. We have also drawn up plans for the development of an ecological site at the western end of the school grounds.

We would like to replenish the stock of textbooks so that they reflect the new courses, present a better image of science and of scientists and emphasise the stronger links with technology, the earth sciences, astronomy and environmental and ecological studies. Considerable thought must also be given to the stock of science books in the school library.

Logistic implications of the development proposals

The staffing implications of our curricular proposals are best shown by the following table.

	Teaching groups × periods		
Year	**Current**	**1988**	**1990 onwards**
1	6 × 4 = 24	9 × 4 = 36	9 × 4 = 36
2	6 × 4 = 24	6 × 4 = 24	9 × 4 = 36
3	6 × 6 = 36	6 × 6 = 36	9 × 6 = 54
4	5 × 5 = 25	6 × 8 = 48	
	5 × 4 = 20	3 × 4 = 12	9 × 8 = 72
5	5 × 5 = 25	5 × 5 = 25	
	5 × 4 = 20	5 × 4 = 20	9 × 8 = 72
6(L)	3 × 8 = 24	3 × 8 = 24	3 × 8 = 24
	2 × 6 = 12	2 × 6 = 12	2 × 6 = 12
6(U)	3 × 8 = 24	3 × 8 = 24	3 × 8 = 24
Total	234	261	330
Increase		27	96

Current staffing/loads

Full-time staff	7 × 40 = 280	Teaching periods 226	Load 81 per cent
Part-time staff	1	8	–
Total		Teaching periods 234	

Future staffing/loads

The increase in teaching periods could be met by an increase in loads and the addition of 0.75 staff in the short term and 2.5 staff in the long term.

Summary of proposals and recommendations

Curriculum changes

Our main recommendations involve the radical redesign of the Years 1–3 science course (page 14) in order to:

improve primary/secondary links (page 8, page 11),
increase the amount of investigatory and small group work (page 8),
enable special educational needs to be met in a more integrative way (page 8, page 13, page 16).

Linked to the integration of Years 1–3 we would wish to introduce in the short term two new fourth year courses:

a double science course for average and above average students (page 15) and a modular science course for the remaining students (page 15–16).

In the longer term these courses would be replaced by a unified modular science course for all students (page 16).

These changes would enable the department to meet more effectively the need to:

provide broader and more balanced courses (page 10–11),
increase the relevance of science lessons for the majority of students (page 12),
introduce more work in astronomy, biotechnology, computer science, ecology and technology,
improve the quality of numeracy in science lessons (page 13),
help the department establish better working links with CDT and home economics (page 14, page 16).

Teaching methods

As set out in the report (page 17), the department is keen to introduce a wider range of teaching methods and obtain a better match between learning objectives and teaching strategies.

Assessment
The department is keen to initiate a radical review of assessment methods and to include a greater element of formative (page 19) and student assessment, leading to the development of 'Profiles of Science Development' (page 19).

Staffing
The staffing implications of the report, including the need to add to the department's strength, have been set out on pages 20–21.

In-service education and training
Our report has identified a number of areas where we will need to utilise school-based and other INSET. In particular we need help with:

the development of alternative teaching strategies (page 7, page 19),
resource-based learning (page 8),
developments arising from new technology (page 8),
the setting, marking and moderation of course work (page 7),
the teaching of girls and ethnic minority students (page 7, pages 12–13).

We also note (page 7) that several members of the department have expressed the need for individual staff development opportunities.

Other resources
The situation regarding laboratories, preparation rooms and other teaching spaces is set out on pages 19–20 and we have also highlighted the need to review our stock of class books and library books (page 12, page 13).

Conclusion

This report represents the outcomes of the first systematic review of science provision ever conducted at Sevenelms School. The department has found the exercise very demanding but worthwhile, and feels better equipped to undertake future reviews as a result of it. While we hope the Governing Body will be able to support our proposals for change, the department will also be using the report to monitor and evaluate its progress over the next five years. Given the rapid rate of change in scientific and technological education, the department is now fully convinced of the need to keep its programmes under constant review.

TWO

The Sevenelms Governors' views

The Head Teacher, Mrs Margaret Connolly, knowing the Governors' concern about science in the school, gave a copy of the departmental review to the Chair of the Governing Body, Councillor Mrs Betty Billing. Mrs Billing agreed that, in view of its importance, it should be discussed at the Governors' next meeting. Copies were therefore sent to all Governors with the following memo:

MEMO

From: Councillor Mrs Betty Billing

To: All members of the Sevenelms School Governing Body

April 14 1987

Review of Science Department

I enclose a copy of the Department's review which will form the basis of our meeting on May 3rd.

Please let me have your written comments by May 1st.

She received replies from the following six Governors:

Margaret Connolly	Head Teacher of Sevenelms (appointed two years ago)
Richard Scott	Vice-Chair of the Governors, managing director of an engineering company in the town
Professor P.G. Rivers	a professor of mechanical engineering and higher education's representative on the Governing Body
Sarah Ellis	a parent governor
John Holding	Head of History at Sevenelms and one of the teacher governors
Brenda Tompkins	pupil representative on the Governing Body, studying A level English, French and Economics.

Sevenelms School

To Cllr Mrs Betty Billing
Chairman of Governors

April 27 1987

Dear Mrs Billing

RESPONSE TO THE SCIENCE DEPARTMENT'S REVIEW

Firstly, can I say how warmly I welcome the science department's review of its activities and commend its recommendations to the Governing Body? As you know, one of my objectives when I took over as head of this school two years ago was to embark upon a major reform of the 11 to 16 curriculum, so as to ensure that all children leaving the school had access to a broad and balanced curriculum which prepared them adequately for their future lives in further education or in work, and across the whole spectrum of their adult lives. I believe that the current review of science teaching in the school will further these aims substantially.

I do not wish at this point to offer a full critique of the science department's plans, but merely to highlight one or two issues to which I feel the Governing Body might wish to give immediate attention.

THE PLACE OF SCIENCE IN A BALANCED EDUCATION

The scientific offer we make at present to the whole range of our pupils is, partly by design, and partly through the exercise of pupil choice, grossly unequal. Highly able students who wish to study science in the sixth form may end up in years four and five devoting over 30 per cent of their time to three scientific GCSE options. At the other extreme, other young people, often the less academic youngsters, can still effectively drop out of science almost entirely from the age of 14. For a variety of reasons, social and cultural as well as academic, girls of all abilities are particularly prone to abandon the physical sciences at 14, so cutting themselves off from a wide range of courses and career opportunities beyond the age of 16.

It is my personal view that all young people of all abilities, including those we define as having special educational needs, have a basic entitlement to a scientific education from the ages of 5 to 16 which will help them attain two objectives: firstly to achieve a minimum scientific competence which will enable them either to continue their scientific studies further or to seek work across the whole spectrum of technical and scientific careers available in modern society; secondly to have gained through their scientific studies in school an understanding of the scientific

and technical aspects of the society in which they live and within which they have to work and exercise political choices. It is my view that a reform of the science curriculum along the lines proposed, both in the short and long term, will help all our pupils across the whole spectrum of ability, sex and ethnic background to achieve the scientific skills and literacy which they need, and which is not offered by the present arrangements. Those who at present experience too little science will have their curriculum substantially extended, and those who wish to specialise will not have their opportunities in any way eroded as they will be able to continue into the sixth form in the usual way, in spite of a slight reduction in the time spent in scientific studies and a reduction in the GCSE passes available from three to two. I am personally satisfied that neither job opportunities nor access to higher education will in any way be damaged by the changes proposed.

THE EFFECT OF THE PROPOSED CHANGES ON THE REST OF THE SCHOOL

The implications of the suggested changes in the science curriculum will undoubtedly affect the school's view of the whole curriculum, the arrangements for its delivery and the amount of cooperation required between previously separate and distinct departments. The overall impact will be one of an increase in time and resources for science and therefore a slight decrease in time (although I would hope not in resources) for other subjects.

There will also be a much greater need for cooperation and coordination between departments which have in the past, in some cases jealously, guarded their separate identities. Much of the thrust of the science department's proposals involve an applied and technological approach to science, which must be sensibly integrated with the work of the CDT department. The thrust towards a consideration of the social and cultural implications of science cannot be considered in isolation from the history department, as well as the English department, with which a useful start has already been made.

Changes of this magnitude will require a period of negotiation and reassessment for the whole staff which will not necessarily be painless. However, I know that there are many members of staff who share my determination to modernise and broaden the curriculum, who will sympathise with the aims of the science department, and who will not allow their own departmental loyalties to stand in the way of changes which are for the real benefit of the pupils as a whole.

THE RESOURCE IMPLICATIONS

Science is an expensive subject. The teaching of science in a more active,

experimental and exciting way is particularly expensive, because it calls for smaller groups and a greater use of consumable materials and apparatus. This is particularly true if science teaching moves into areas like information technology, biotechnology and electronics, which are regarded as of major importance to the economic future of the country.

An initiative of this sort cannot hope to succeed without substantial support from the local authority in the way of resources for capital equipment, capitation to cover the extra costs of consumables, and extra teaching and non-teaching staff, where justified. If the Governors, after full discussion, are convinced of the virtue of the science department's proposals, then they might wish to ask the science department to undertake a full costing of their plans. The school would then be able to discuss with the LEA science advisory staff a detailed breakdown of the full implications of their science curriculum policy for this school. It is my personal view that these developments cannot be carried out without proper additional funding.

A further consideration for both the school and the local authority is the extent to which in-service training will be made available – with full replacement cover for absent staff – to members of the science department embarking on these wide-ranging reforms. I would regard adequate in-service training, of the sort outlined in the review, as a prerequisite for the implementation of the science department's plans over the next one or two years.

Bearing in mind these reservations, I see the science department's review as a major step towards a reform of the whole 11 to 16 curriculum in this school which will improve motivation, raise standards, and increase opportunities for all our young people.

Yours sincerely

Margaret Connolly.

Margaret Connolly
Headmistress

University of Marston

Department of Engineering

Cllr Mrs B. Billing
Chairman of Governors
Sevenelms School

April 29 1987

Dear Mrs Billing

I write in response to your request for comments on the science department's review. While welcoming such a report and acknowledging all the hard work which it has entailed, there are many aspects of the proposals for the future which concern me from the vantage point of my own university engineering department.

While agreeing with the department that secondary science education is important for all our future citizens, I see that in providing all the pupils in the school with these broad science courses until they are 16, many of them will actually be doing less science than they do now. I am of course talking about the potential scientists and engineers of the future who at the moment probably do all three sciences in the 4th and 5th year. What will happen to these young people who are very keen on science and who need a good grounding in the basic principles in order to grasp the undergraduate work? Not only will they have less time allocated for science but they may then be forced to do subjects at which they are not very good or do not enjoy. Would not this be a waste of their time? Surely, many of these other subjects can be picked up as hobbies if the children are interested in them; it is not possible to do this with science subjects.

If these new courses come in, what will this do to the content of A level courses? Either they will have to change to accommodate the work which is not covered in GCSE or we will find that the three grade Bs which we currently demand for acceptance on to our courses will carry a different meaning than at present. Already with current A level standards, we have great difficulty getting everything into the three year undergraduate courses, and this problem increases every year as the knowledge base increases. If they are going to be doing less in schools than they do at the moment, we will have even more catching up to do with them when they reach us and this is already a major headache for many of my colleagues.

In order to practise engineering, you need a wide background knowledge and a good understanding of the basic principles of physics and chemistry. Already we find that some of our students need a great deal of extra coaching in their first year if they are to get anything out of their lecture programme, and their lab work

leaves much to be desired in many cases. Having less time for science is not going to help this situation at all. Indeed, it could be argued that these young people do not get enough time already for their science studies. They need a great deal of practice, particularly in mathematical calculations and use of new technology.

My main problem with these proposals then is that I fear that in jumping on this bandwagon which they call "science for all", the science department is in terrible danger of lowering standards for those young people with whom I have most dealings. The only redeeming feature of such an initiative, as far as I can see, is that it could help to keep girls in the sciences until they are 16 and therefore they might continue with A levels. In recent years hardly a conference goes by without my being encouraged to take girls into my department, and it is a notion I have some sympathy with, particularly as the two females who graduated with us in recent years have been excellent students.

I trust these comments are of use to you.

Yours sincerely

P.G. Rivers

P.G. Rivers
Professor of Mechanical Engineering

Swithland and Scott Engineering

Cllr Mrs B. Billing
Chairman of Governors
Sevenelms School

April 20 1987

Dear Councillor Billing

I am grateful for the chance to comment on the science department's proposals and encouraged to be involved at last in the real work of the school.

I find the proposals something of a 'curate's egg'; as an industrialist responsible for employing young people in the town I welcome some of the ideas but view others with some alarm.

Let me at this stage confine myself to six main areas.

Basic knowledge

The big question, as we see it, is 'What can we expect them to know and be able to do?' Nowhere in the proposals do I find a clear statement of what this is now or how it is going to change in the future. This makes our life very difficult. So often we have to start all over again, not least in the basic areas of English and mathematics.

Science subjects

As I understand it, the science subjects that we all understand so well – chemistry, biology and physics – will disappear and become something called double or modular science. Am I right? Because if so, this does worry me. An engineering firm like ours depends upon a sound knowledge of physics, whereas biology, for example, is really not very important. This is something that I shall certainly want to explore more fully.

Pupils' interest

I do find it strange and sad that pupils' motivation is falling off in the second year, in a subject as exciting and relevant as science. Look at the numbers studying chemistry – appalling! Thank heavens the department wants to do something about it, but what is wrong, the teachers, pupils, lack of money or what? I have to be careful here but I do know that my own daughter finds her science lessons very tedious indeed, with endless note making and so much to be learned for the weekly test. It seems to me that her teacher has most of the fun while the kids stand around watching. And so much of it is unrelated to real life (she seems to have spent the whole of last term trying to balance chemical equations – what is the point of

that?). When I ask lads at interview about some current affairs or practical aspect of their science they are most often reduced to dumb silence!

Relevant science

The school must pursue the possiblity of bringing science and technology together. They have a lot in common nowadays and the science teachers might learn a bit more of everyday value. Incidentally, I wonder if any of them would want to spend some time working here to get a bit of wider experience? I could easily fix up a couple of weeks for someone in the summer holiday. I see that 'real issues, problems and real life examples of science in action' are to be a feature of the new approach. I say 'hoorah' to that but I ask how the teachers are going to find out about such things.

Industry's responsibility

I do seriously believe that we in industry are going to have to play our part in all this. A firm like ours desperately needs qualified scientists, engineers and technicians if we are even going to survive. You know what a dreadful time we are going through and most of our problems are caused by out-dated equipment and techniques. For our own sake we must try to get together with the school and see how we can encourage the science teaching. Can we supply any materials? Could they make use of our training school facilities? I have had my eyes opened by our Youth Training Scheme. Kids who were the real dregs of the schools, switched off and truanting, really coming up trumps when they are given something useful to do.

Assessment

One final comment on the science proposals from my industrial position. I said earlier that it would be helpful to know what science the school leavers are supposed to know. What is the base level of knowledge? But equally important for us is to know what the young man who applies to us is like. Is he reliable, punctual, persevering? Can he work successfully with a very mixed group of other people? Can he lead such a group when necessary, show initiative, have sensible ideas? You must have seen those adverts for Sandhurst.

Will the new school science help and encourage that sort of thing? (I see little of it at the moment with Samantha.) I reckon a lot of our problems would never have arisen if only people had been able to interact, listen, make suggestions, etc.

As a firm, we have become really interested in 'profile assessments' which try to indicate a person's achievements in all the different aspects of their work and character. I very much hope that something of this kind will emerge from the science department's reappraisal of its work. It seems too good a chance to miss. Quite

frankly, examination grades are useful but they are only one part of a boy's overall profile.

So, in summary, I don't want to see the baby thrown out with the bathwater but we must give every encouragement to the science department to make the subject more lively, more relevant and more successful for as many pupils as possible. I would go so far as to say that the national economic survival depends upon this.

I look forward to the discussion at the Governor's meeting. The managerial implications of all this are huge, aren't they?

Yours sincerely

Richard Scott

Richard Scott
Managing Director

71 Larkrise Road
Staveley
April 24th 1987

Dear Mrs Billing

Science Department Review

I am writing as you asked with some of my reactions to the report from the science department. You will understand that there has not been enough time to consult many other parents but I have managed to talk with a few neighbours and friends and they generally seem to share the concerns that I have as a parent. (You will remember that Andrew is in the fourth year and Sally started at Sevenelms last September.)

It will not surprise you to learn that my main worry at the moment is about examinations. Andrew will be taking GCSE biology, chemistry and physics next summer and he wishes to continue to study science subjects in the sixth form. As I understand it, the science department is suggesting that in future taking three separate science subjects will not be possible. This bothers me in two ways. First, pupils do have particular interests and should be allowed to follow them and second, will the new courses be a proper preparation for advanced level work. Heaven knows, it is difficult enough now to become a vet without making it any harder.

I am also concerned, as are the other parents I have talked to, about whether the new courses will be acceptable to local employers and the universities. Jobs are hard to get and my contacts at work do tell me how important physics is. This brings me to another worry, will employers and others trust the new examination and assessment procedures suggested, even if they accept the courses. The GCSE exams do seem to rely much more on the teachers to grade the pupils and the department seems to want to go further than this and give the pupils some responsibility for their own assessment. Surely this will make the whole thing very suspect and result in a lowering of standards.

I am also not at all clear just what the new courses will mean in terms of what the pupils will learn. We do seem to be adding a lot. Will they still deal with the important parts of chemistry, physics and biology? If so, is there enough time? I hope we can be reassured about this since I can see some value in these subjects. (I do regret not doing any physics or chemistry myself at school.) Talking about what the youngsters will learn does give me a chance to ride a particular hobby horse of mine. I welcome the extra emphasis which the department would seem to want to give to health education. This really is important, and I hope will go

a bit beyond learning about the body's plumbing in biology, which is just about all Andrew seems to have managed to date. Caring for ourselves as individuals and for other people as individuals seems to me to be so much more worthwhile and needs a broader approach.

I realise that up to now I have been fairly negative about the changes suggested, particularly in the way I see them affecting examinations and career prospects. But there is one way in which I do look much more favourably on the report. Sally enjoyed her science at first, the novelty of a laboratory and a teacher in a white coat was exciting, but there are signs that she is beginning to 'switch off'. I cannot be at all sure that she will want to carry on with science subjects when option time arrives. Part of the problem is that at Fairfield Primary they really did manage to get involved in some fascinating 'finding out' – I even enjoyed it myself despite having to help on occasions with aeroplane-making and pond-dipping. I am pleased therefore, that the department plans to change its approach in Years 1 and 2.

In a similar way, a number of parents are pleased that the new scheme should mean that both girls and boys will continue to study science up to 16. (I have already mentioned my own regrets about not doing this.) So, if we can be reassured about exams and standards it is not all bad news.

There is another worry that I have had for a long time but never quite had the courage to say in public. The science department's report gives me a chance to air it. They talk about 'changing teaching styles' and 'variety of approaches'. I hope this means making lessons less boring. Some teachers manage it but a lot do not and we all know what a difference this makes to how interested and willing to work children are. Sally's first history homework from Sevenelms, for example, involved her looking at some evidence from an accident and behaving like a detective to work out what had happened. She loved it. For science she had to copy out the lab. rules from her rough book to her neat book. Not much competition for Dallas I am afraid.

I was also pleased to see the department's mention of 'special needs' and giving this area more attention. I am sure this is right and does, I believe, mean more than lifts for the disabled. Not everyone finds learning easy for all sorts of reasons. Sally is dyslexic and has real problems with spelling and reading worksheets and textbooks. She gets a lot of help in English but in science simply has to cope along with everyone else and it is making her much more nervous and hesitant about tackling the work, which is a shame since she was very keen and well able to talk about what she did and was learning.

You will recognise that so far I have stuck very much to wearing my parent's hat and given a lot of emphasis to personal concerns but there is a cause which I think we as Governors really must support. I mean of course the money issue. When I last walked around the school – you will remember the conducted tour – I was appalled by not only the state of decoration but also the textbooks. Pupils sharing books, books falling apart (and I see lots of these at home) and surely, too, science does need more than just books. I feel that you and the other councillors should at every opportunity argue our case with the local authority and with the Education Committee. You will certainly have my support.

As a last point, you know that I, and I am sure the rest of the Governors, have every confidence in our Head Teacher, so if Mrs Connolly is in favour of the changes, I will be very happy to trust her judgement.

I am sorry to have gone on at such length but I hope you find my comments helpful.

Yours sincerely

S. Ellis

Sarah Ellis (Mrs)

Sevenelms School

MEMORANDUM

From : Head of History, Mr J. Holding April 28 1987

To : Councillor Billing

Science department review

You asked me to provide written comments on the review document. Broadly speaking, I welcome the document, its analysis and its proposals, but I have serious reservations about some of its implications.

I would like to report my feelings under these headings:

- The nature of what is taught
- How it is taught
- Implications for the rest of the school
- Implications for the science staff.

I must make it plain that while I sit on the Governing Body as a representative of the staff and would therefore wish to represent their interests, I am also Head of History and this may somewhat affect my perspective.

The nature of what is taught

I have long been aware that much of the science taught in the school seems to be found boring and difficult by the students. I base this impression on comments of students in my tutor group as well as passing comments of students I teach. The impression is borne out by the fact that when option time comes, relatively low numbers seek to take the study of science further. They are, as it were, 'voting with their feet'. I must say in passing that I find it odd, in view of option numbers, that the science department intend teaching more, rather than less, science – but I will return to this point later.

It seems to me that part of the reason for students' disaffection with science may be its lack of relevance. They seem to spend a lot of time learning about theories, but little finding out about the importance of science in real life. I recently asked a group of bright fifth formers to explain to me what had happened in the Chernobyl nuclear reactor accident last year but none was able to, even though most of them studied physics. This, and other anecdotal evidence, seems to point to a lack of what one might term 'scientific literacy', which surely is the one thing science education ought to provide.

I therefore welcome the proposal in the science department's report that the new

courses should be more relevant to society and place more emphasis on the technological applications of science. If properly carried out, this policy should increase the scientific literacy of our students and make the subject more appealing and popular. I suspect it may also go some way towards solving another problem: the lack of appeal of science, particularly physics and chemistry, to our girls.

I also welcome the proposal that the cultural perspective of our science lessons should be widened. In view of the varied ethnic mix among our students, a wholly western view of science seems inappropriate. In any case, from a humanities specialist's point of view, such a widening of cultural perspective can only make science more interesting.

However, if the perspectives of science are to widen, it will be more important than ever to coordinate with other departments. There is a real danger of duplication between science and, say, geography or personal and social education. Departments will need to liaise with one another to ensure that, between them, they provide a broad, balanced and appropriate programme for each student.

How it is taught

I agree with my science colleagues that there is a problem of lack of continuity between primary and secondary school. I agree with their analysis of the difference between primary science – topic based, interdisciplinary, actively involving children – and secondary science – often didatic, teacher-centred and narrow.

I therefore welcome the department's proposals concerning teaching styles: away from the traditional teacher-centred approach, towards more self-directed, active learning, closer to the style encountered in primary school. I also welcome the emphasis on group work, discussion and problem-solving, as activities more akin to the way people work in real life.

I might venture to suggest that the science department may have something to learn from other departments before embarking on the adoption of these new teaching styles.

Implications for the rest of the school

Having welcomed certain features of the proposals, I must now express my reservations, which concern the role of science in the school as a whole, and the implications of the proposals concerning timetabling and resources.

The proposals suggest that all students follow a balanced science course to 16. This is in contrast to our present system, whereby many students opt away from science at the end of the third year. Admittedly a reduction of overall science content is

advocated, and the small number of students who study all three sciences in the fourth and fifth years will actually have a reduction in their total science time. But this will be outweighed by a substantial increase in the total amount of science studied by those who formerly opted away from the subject. The net result will be a substantial increase in the total amount of science taught, and this time can only be provided by a reduction in time spent on other subjects.

Where are the science staff to meet these needs to come from? The national shortage of science teachers is well known. Will it mean a contraction in other departmental staffing? Quite apart from the staffing implications, does it make sense to expect children to study more science, when by their option choices they are saying they want less? The science department says the new curriculum and style of teaching will make science more attractive, but I would want evidence to show this was true.

Another problem arising from the expansion of science concerns resources. Science is already an expensive subject, taking a disproportionate share of the resource 'cake'. This expansion will require still more resources. Where are they to come from? One suspects from other departments.

I must thus register serious misgivings about the possible effect on the rest of the curriculum of the proposed expansion of science.

Implications for the science staff

These changes have particular implications for the science staff. I realise that the Head of Science has been scrupulous in involving the department fully in discussions leading to this report. Nevertheless, I am aware that a number of science teachers are concerned about its implications. Above all, they are concerned at the prospect of teaching outside their subject specialisms, as is likely to be the case with the new integrated science courses. They are concerned at having to teach reluctant children who have been compelled to take science as part of a compulsory course. The Head of Chemistry, in particular, is also concerned that students going on to study A level chemistry may be inadequately prepared by the new integrated science course. A number of science teachers are also worried about the change of style that will be expected of them, and about the need to cover social and technological aspects with which they are unfamiliar.

All this suggests that the science staff must be properly prepared for the changes by means of a thorough programme of in-service training.

May I conclude by saying that my reaction to the report is a guarded welcome: a welcome because the aims and strategy seem timely and appropriate, but guarded because of its likely effect on other departments in the school.

John Holding

Tel: 313

The Larches
Woodbury Stoke

30 April 1987

Dear Mrs Billing

Thank you for sending me the science department review and for asking me to comment on it. I hope that these remarks reach you in time for the meeting – so sorry that they are late. I had intended to write earlier but I have been trying to contact as many students at school as I could, so that my remarks would be more representative.

I am really happy to read that the science department is going to give more attention to the applications of science in the future, and this should make lessons more interesting, especially for those students who will not be taking science further on. As you may already know (I think I mentioned it when you asked me what I was studying in the sixth form), I am doing arts subjects mostly because the thought of continuing with what I must confess was a boring set of sciences did not appeal to me. I know that my parents were a bit disappointed about that because they remarked that it was not all that easy to get jobs with arts subjects.

It seems as though part of the idea for changing the science courses in the lower part of the school includes reducing the content of the courses. Whilst I, and other arts students in the sixth form, would not mind this happening, I know that some of the students who are hoping to study sciences at polytechnic or university would be unhappy. They say that there is so much to do that if there was less content in the first five years, and therefore more in the sixth form course, life would be unbearable! Already the science students complain that there is a lot of work to do, and they spend time in the laboratories in addition to all the theory. The syllabuses at A level are quite extensive, and if the students are to get good grades for entry to higher education it is their belief, which I also share, that it is never too early to start proper learning. That brings me to a related point concerning the ways in which we were taught science in the early part of the school. I feel that the science I did was very general for the first three years, and it was only when we were seriously studying for the examinations that we really got down to it. In addition, it was quite noticeable that the teachers were more interested in teaching us when we had an examination to aim at. I heard the other day that it is possible that the school will become 11-16 eventually. I think that would be a great shame, because I think the teachers will not care so much about what they teach because without A level the teaching will not be so important, and will not lead anywhere for them.

I think that the remark about science in primary schools being excellent, and not being continued in secondary school, is a good one. I remember our fourth year teacher at Fairfield getting us to do a survey in the town and follow-up work in school, which we all enjoyed. It was great coming to the secondary school to do more science in real laboratories, but somehow we seemed to get bogged down eventually, certainly by the end of the second year (as they say in their report). It is a pity, but inevitable I suppose, given what I was saying about the need to speed up the important learning over as great a time as possible. I hope that the science department do find a way of making science more interesting, and what they say about project work could help. I am not quite sure what they have in mind about "project work" because the kind of project work I have done since coming to secondary school was very different from that which I have already mentioned in primary school. For one thing there does not seem to be the same opportunity as you grow older for asking the questions you wish to ask. The questions seem already set by the teachers. Also I am not certain where the materials will come from, because we are already short of a great deal, and I notice that the science department report hardly mentions that. There are some good teachers in that department, and I am sure that if the materials, etc. can be found, they will enjoy teaching science more than they do now.

One way of making the science more interesting would be to look at the history of the subjects studied, and see how that is relevant today. Some of the programmes on TV, which show how scientists are also human beings with their own domestic and personal problems, help me to realise just how hard it was for them to discover the things which they did; but it also reassures me. There are many problems which we face every day which could be made easier if we all know a bit more about the right sort of science. I am not quite so sure about the bridge between science and craftwork in school – the two seem separate to me (and some teachers in the two departments do not seem to get on too well with one another). If it means that more girls will do craftwork and, therefore, science eventually, then that might be a good thing, I suppose. It might also help to overcome the problems which arise from the fact, which many girl friends of mine have noticed, that boys seem to believe that they should automatically be better at science than girls, behave like that in class, and expect the teacher to see it that way too (which many do).

I know from talking to a lot of students that while they would welcome the ideas in the science department report, they (and their parents!) are worried about the courses as a preparation for the examinations which we take. I have heard that integrated and combined science is not such a good preparation for examinations as are the separate courses. My uncle, who is in charge of recruiting people for his company, says that standards are going down in basic subjects and that

employers are not keen on these 'mixed' kinds of courses. I suppose the pupils' certificate, which some of the students are now getting at the end of the fifth form, will help to show not only that we are able to do well in subjects we study at school, but also that we have other qualities and interests which make us people in our own right. But will that be as useful as the present examination system for when we leave school and go to work or to further study? I hope so, for I know that many of the students really enjoyed discussing their progress with the year tutor, and agreeing what was said about their achievements and interests both in and out of school. When the scheme is extended to include the more able students I think it will help a great deal to bring about the kind of changes which the science department report describes.

Yours sincerely

Brenda Tompkins

Brenda Tompkins
Student Governor

On reading these replies, Mrs Billing decided to seek help from the LEA's professional staff. Her initial enquiry to the Chief Education Officer was passed to the Science Adviser, Gerald Lucas, who wrote her the following letter.

MARSTON COUNTY COUNCIL

Cllr Mrs B. Billing
Chairman of Governors
Sevenelms School

Dear Councillor Billing

Thank you for your enquiry about the Sevenelms science department report. My team and I have helped the school on a number of occasions with their science review so the contents of the report were familiar to me.

I am enclosing a further copy of our circular 'Science 5-16' and a summary of the recently published recommendations of the Secondary Science Curriculum Review, which I believe you and the other Governors will find helpful.

You will see that, broadly-speaking, the Review supports the changes being proposed by the Sevenelms science staff. I, personally, welcome their initiative but, as I am sure you will realise, the successful implementation of their proposals will depend upon decisions taken at a number of different levels.

My colleagues and I intend to give all possible support to the School's efforts, which are very much in line with other developments in the Authority.

Yours sincerely

G. Lucas

Gerald Lucas
Science Adviser
Enc.

THREE

What is the Secondary Science Curriculum Review?

The Secondary Science Curriculum Review was set up in 1981 to bring about changes in science education in our schools. It reflected the growing concern that science, while a major curriculum area, was not in fact meeting the needs of many young people and of society in general. The aim of the Review is to encourage schools to provide a broad-based science curriculum up to the age of sixteen for all students.

At the moment, it is possible for some students to give up science at 13 or to continue with just one science subject, for example biology. Girls in particular have often restricted their choice to biology alone and have thus gained only a narrow experience of science.

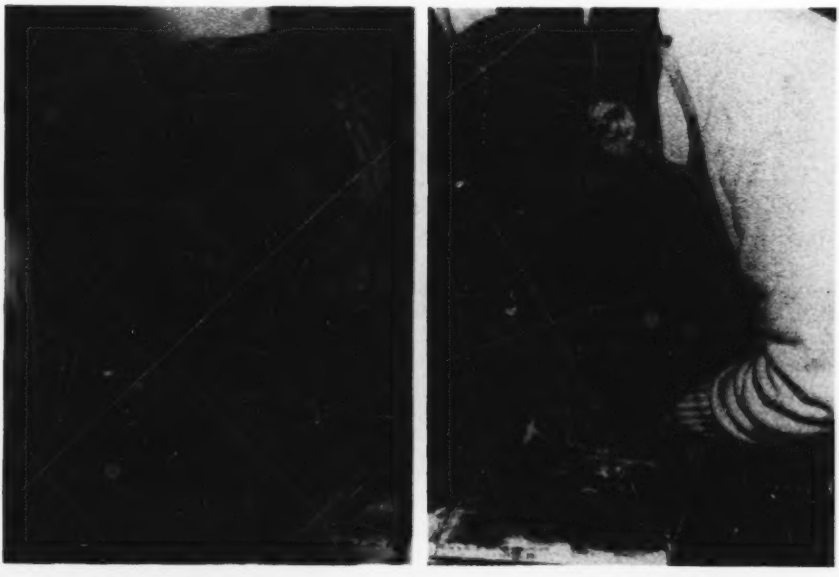


Fig. 6 In the late twentieth century, it is essential that all students leave school technologically and scientifically literate

In the late twentieth century when science and technology are increasingly affecting every aspect of everyone's life, it is essential that all students leave school technologically and scientifically literate.

Who Is Involved?

The Secondary Science Curriculum Review consists of a network of groups of teachers throughout the country working closely with a central team. The Review has been sponsored by a number of national agencies, including the School Curriculum Development Committee, the Association for Science Education, the Department of Education and Science (and its Northern Ireland equivalent) and the Health Education Council. It has also attracted support from the industrial and commercial community. Representatives from all these interested parties, together with others from the Secondary Examinations Council, the examination boards and the Standing Conference on University Entrance, make up the Steering Committee for the Review. It thus claims wide support in the educational world and has in its development consulted with many other institutions and agencies. The Review is committed to achieving the reality of 'Science for All'.

What Does It Set Out To Do?

1 To provide a broad common base of science education for students of all abilities, both sexes and all backgrounds. Additional material will be provided to meet the needs of individual young people with special needs.
2 To avoid early specialisation and keep open subject and career options for all students for as long as possible, thereby increasing educational opportunities.
3 To increase the amount of time spent on science by the majority of school students up to the age of 16. It is suggested that 11 to 13 year-olds spend ten per cent of their time on science, 13 to 14 year-olds fifteen per cent, and 14 to 16 year-olds twenty per cent.
4 To replace the option of three sciences at GCSE level with a course which would lead to two GCSE passses in science. It is intended that double science will be an appropriate preparation for A level courses in separate sciences.
5 To encourage schools to redesign their science syllabuses taking into account the learners' own needs and interests, the demands of advanced technology and the kinds of skills it requires, and the social and ethical implications of science.
6 To encourage science departments into a closer working relationship with other curriculum areas so that students may understand that science does not provide the only way of looking at the world and that the human condition may be explained from other perspectives.
7 To enable pupils to emerge from their science courses with sufficient confidence and information to deal with the applications of science in the adult world, and to continue to use and develop the skills they have learned.

Why Make These Changes?

Underlying these developments in science education are changes in how science is perceived as an area of study and a re-evaluation of how students learn. Whereas in the past science was seen as a body of knowledge consisting of objective, neutral facts, it is now regarded by many as a practical activity which is influenced by the values of the society in which it is practised. At the same time, it has been realised that pupils bring to their science classes their own ideas about how the world works which may be in conflict with conventional scientific ideas.

These changes in the perception of science bring with them the need

To encourage the development of teaching styles which will engage the learners' imagination in an area which is inherently fascinating. This may be achieved, for example, by relating the content of science lessons to the students' background and experience, by a more sensitive use of language to encourage exploration of their own ideas about science, or by a variety of other means.

To affirm the central importance in science education of the relationship between teacher and learner, which should be one of total trust and respect. This should lead to students and teachers working together in the laboratory, sharing the excitement of scientific discovery.

To develop in students a sense of responsibility to themselves and others and to the environment in which they live, so that they are able to make informed decisions which affect their own lives and which contribute to the well-being of society as a whole.

To help students clarify their own ideas on the scientific and technological issues which affect individuals and society so that they are able to participate fully in a democratic society.

What Has The Review Achieved?

Over the last five years teachers from more than 80 local education authorities have become involved in working with the Review. This has meant first identifying for themselves particular interests and concerns linked to their science teaching. Usually working in small groups, they have then followed up these interests, often producing as a result new teaching materials and approaches to science education.
Through these activities, many teachers have had the benefit of working with fellow professionals from other schools and have developed their own skills and practices, to the advantage of their students. So the Review provides an important network for the exchange of ideas, materials and good practice. There

are other parts to the network too. In the process of development work, individual working groups and the Central Team have made contact with a wide range of other agencies with an interest in science education. The national broadcasting companies and a number of major industrial concerns are examples. Conferences have provided one means of developing and promoting this extended network.

A further valuable outcome of Review activities has been an increasing recognition within the science teaching community of the need to keep the science curriculum and its translation into practice constantly under review.

As might be predicted, the work described above has led to an extensive range of publications, some produced by groups, local authorities or the Association for Science Education, others released through commercial publishers. Important in this latter category are the following:

1 *Better Science: A Directory of Resources*
A classified listing of the published outcome of the development work of the project's local groups, with two supplements.

2 *Curriculum Guides*
A series of twelve teacher's guides collected together as a set which are intended to help science teachers and science departments to review and change their ways of working. The titles are:

Better Science: Key proposals
Better Science: Choosing content
Better Science: Making it relevant to young people
Better Science: Approaches to teaching and learning
Better Science: How to plan and manage the curriculum
Better Science: For both girls and boys
Better Science: Working for a multicultural society
Better Science: For young people with special educational needs
Better Science: Health and science education
Better Science: Building primary–secondary links
Better Science: Assessing progress
Better Science: Learning how to teach it

3 *Better Science: Making it happen*
This publication is not directed specifically at the science teacher. Through an account of one school, it explores the growth and development of the science element of that school's curriculum. It is of particular interest to parents, governors, and others with an interest in or responsibility for curriculum planning and implementation.

All these are published jointly by Heinemann Educational Books and the Association for Science Education. They represent a valuable resource for science teachers and others with an interest in a developing science curriculum. See Appendix II for further details

The Archive

The full range of documentation produced by all those involved with the Review during its five years of activity is held in a central archive located in the headquarters of the School Curriculum Development Committee, Newcombe House, 45 Notting Hill Gate, London W11 3JB.

What Is Happening Now?

The Review is in a new phase. Some development work continues but much of the Central Team's efforts are now directed towards disseminating and promoting the ideas and products resulting from the first five years of work. This will involve making a major contribution to in-service programmes across the country.

FOUR

The Sevenelms School Science Action Plan

Extracts from the minutes of the meeting of Sevenelms Governing Body on May 3rd, 1987

There was a lengthy debate about the science department's review, the six responses from governors, and the science adviser's letter to Mrs Connolly. The governors again commended the initiative of the school's academic board in encouraging departmental curriculum reviews and congratulated the science department on its detailed professional response.

It was noted that the department's new thinking was in close agreement with the development described by the science adviser which, in turn, was supported by several important national bodies.

The governors unanimously wish to encourage and support the department's concern to interest and involve all students in science, to introduce more relevant and applied science into the courses and to relate science to other areas of the curriculum.

Some concern was expressed about the following features of the proposals:

1 *The possible unsuitability of integrated science courses as a preparation for separate A level science subjects*
It was noted, however, that point four of the adviser's letter specifically covered this point and Professor Rivers agreed to seek further information on this point.

2 *The acceptance of integrated science qualifications by local employers*
It was agreed that a public relations exercise would be needed to explain the nature and purpose of the change, but that many employers would probably welcome the greater relevance of the new courses. Mr Scott suggested that a talk to the Rotary Club and Round Table might be a start.

3 *The urgent need for better facilities and in-service training*
It was agreed that without a commitment from the local authority to improve the laboratory accommodation the scheme would not succeed. Mrs Connolly drew the governors' attention to a new

programme of in-service training being organised by Mr Lucas, the science adviser.

4 *The implications for the balance of the whole curriculum*
The governors sympathised with Mr Holding's worries about the effect of the proposed change on other areas of the curriculum. They urged that the process of change be conducted in such a way that existing staff were not unwillingly displaced and pupils' present courses were not disturbed.

The governors expressed their support in principle (16 votes in favour, 3 abstentions) for the proposals contained in the science department's review. However, they reserved their final position until more of the practical implications of its implementation had been clarified. Accordingly, Mrs Connolly was asked to prepare an action plan for the next meeting of the Governing Body on October 26th, 1987.

The relevant minutes of the meeting of the Governing Body of Sevenelms School held on October 26th, 1987 are printed below.

Extract from the minutes of the meeting of Sevenelms School Governors on October 26, 1987

Mrs Connolly introduced her Action Plan for the changes in curriculum proposed by the science department under the following headings:

1 Teaching staff
2 Ancillary staff
3 Building and room implications
4 General resources
5 In-service training
6 School management issues
7 Community relations

1 TEACHING STAFF
The Head Teacher reported that 1.5 full time teachers of science additional to the department's existing establishment would be required by the new scheme. The Clerk reported that the Authority's science curriculum policy allowed 0.5 additional staff over establishment for a school of Sevenelms' size which was implementing a policy of 'science for all'. She suggested that the department be asked to re-examine its

proposed student groupings and staff deployment with a view to making some limited savings. The implications for future long-term staffing would be raised by the Head Teacher with the science adviser in the next round of staffing discussions.
Action: Mrs Connolly
Head of Science

2 ANCILLARY STAFF
The review predicts the need for additional technician time to support the department, equivalent to half a full-time person. The Head Teacher reported that the allocation of points for ancillary staff were already fully committed and since no immediate release of points looked likely, she could see no way to meet this requirement.
It was agreed that

(i) the Clerk to the Governors would write to the Director of Education requesting an interim increase in points establishment for the school pending future resignations or retirements, when changes to meet the new priorities might be made;
(ii) the science department be asked to look carefully at its existing deployment and management of technician staff with a view to making the most of a limited resource within the proposed new scheme.

Action: Mrs Connolly
Head of Science

3 BUILDING AND ROOM IMPLICATIONS
It was agreed that the modification and up-dating of existing specialist laboratories were needed. The Head of Science was preparing preliminary plans. It was agreed that the Clerk to the Governors should write to the Director of Education and the Head Teacher would contact the science adviser, in order to initiate building development.
Action: Mrs Connolly
Clerk to the Governors

4 GENERAL RESOURCES
The Head Teacher endorsed the view of the Head of Science that the new courses would require expenditure on up-to-date textbooks and new equipment. The Head of Science was preparing a detailed costing. It was agreed that in the meantime the Clerk to the Governors would write to the science adviser to ask whether any additional monies could be made available by the local education authority to fund the initiative.

Mrs Ellis said that a recent meeting of the parent-teacher association committee had been very supportive of the proposed changes. She would consult them about the possibility of extra fund-raising by the parent-teacher association specifically for the science department in these exceptional circumstances. The staff representative wanted it minuted that he was strongly opposed to the principle of parent-teacher association funding for essential resources which should be provided by the county.

Mr Scott commented that the local business and industrial community would be pleased to hear of developments in the fields of micro-technology and electronics and he would sound out colleagues to see if help could be obtained from sympathetic local employers, possibly for the purchase of microcomputers.

Action: Clerk to the Governors
Mrs Ellis
Mr Scott

5 IN-SERVICE TRAINING

It was agreed that the changes envisaged by the science department would necessitate substantial in-service support. The most urgent needs were identified as follows:

(i) Retraining staff in the teaching of science subjects or modules outside their current expertise.

(ii) Support for all science staff in new techniques of assessment, particularly with respect to those required in connection with GCSE and with the profile development project within the school. The latter activity would require staff to be trained in the development of negotiation skills in dealing with individual students.

(iii) Support in the management and evaluation of curriculum innovation.

(iv) Support in the organisational implications for departmental personnel.

(v) Support for non-racist and non-sexist teaching strategies and the selection of un-biased materials.

It was agreed that the Head Teacher would contact the science adviser about resources available for in-service support in science, and possibilities for retraining in science specialisms in local institutions. It was agreed that the Head of Science would contact Mr Scott

and visit his department to discuss possible support.
It was agreed that the Head of Science would investigate the availability of school-based evaluation material for curriculum innovation from higher education institutions and from the School Curriculum Development Committee.
Action: Mrs Connolly
Head of Science

6 SCHOOL MANAGEMENT ISSUES

The Head Teacher reported on the progress of consultation with colleagues on implications of the proposed changes in the science curriculum.

(i) At a meeting of Head Teacher and deputies the full implications of the proposals for curriculum balance, staffing, capitation, building needs and community relations were discussed. The Deputy Head (in charge of time-tabling) had made initial calculations on the effects of increased use of specialist rooms. The Deputy Head (in charge of community relations) had prepared a list of parties to be consulted or informed.

(ii) The Head Teacher had had a discussion with the Head of History, staff representative on the Governing Body, about the presentation of the plan for curriculum changes at a full heads of department meeting.

(iii) A meeting of heads of department was held with the agenda issued well in advance, plus a paper prepared by the Head Teacher. Time had been allocated for departmental meetings to discuss that paper in advance of the meeting of heads of department.

(iv) A meeting of heads of year to discuss pastoral and curriculum implications for pupils had been held.
  (a) There was discussion on the third year option process, how information would be sent out to parents and the nature of the presentation of the third year parents' evening.
  (b) Plans for monitoring the progress of fourth and fifth year students in the new curriculum area were developed.
  (c) A consultation was held with the Head of Sixth concerning university applications. (Careers staff were present at this session and would convey the implications to the local careers office and local employers.)

(v) The curriculum proposals had been an agenda item at a full staff meeting.

(vi) Discussions had been held with ancillary staff concerning
(a) the changing routine for laboratory technicians
(b) the organisation of the movement of equipment over the summer holidays by the caretaker.

(vii) A full timetable of proposed changes had been made available to all.

7 COMMUNITY RELATIONS

The parent governor welcomed the support of the governors in implementing the changes in science, and proposed sending a letter to all parents explaining the nature of these changes and their desirability in educational terms.
Action: Mrs Connolly

Mrs Ellis made it known that she would be willing to deal informally with enquiries from other parents.
The higher education representative expressed some concern at the decision, and advised that an approach be made to the admissions officer of the local university and polytechnic to explain the effect these changes in science might have on higher education entrance. Professor Rivers would inform colleagues at his university via the Board of Studies and Area Committees.
Mr Scott also expressed some doubts as to the wisdom of the move, particularly in relation to the expectations of local employers in terms of the qualifications of school leavers, and suggested that representatives from industry be involved in redesigning the science syllabus, particularly in the area of applied science. Mr Scott said he would contact local employers at a Rotary evening and sound out their interest.
Action: Mrs Connolly
Mr Scott

The student governor suggested that, because of the importance of the changes, an article in the Woodbury Stoke Gazette would be a good idea, especially if it could show the exciting nature of the new course and that it would help girls in particular. Perhaps a talk at the school by a leading person in science education would attract a lot of attention and be reported in the Gazette. The Head was asked to invite the chair of the Association for Science Education to give an open lecture in school and to invite the press.
Action: Mrs Connolly

The Head Teacher again drew attention to the local education authority circular, *Science 5 to 16, a statement of policy*, issued in September 1986, which contained many of the educational principles which the science department was preparing to implement. She would request additional copies from the local education authority for circulation.
Action: Mrs Connolly

FIVE

Some conclusions

Making change is never easy. No two education authorities or schools are alike, and relationships between individual schools, their own neighbourhoods and the local authority must, by definition, be unique. Even so, we have felt it well worthwhile, through the Sevenelms School simulation outlined in this book, to attempt to illustrate some of the problems any school might face in attempting to introduce a radical curriculum change in one subject area. Such problems and issues can arise even in a school like Sevenelms which has a well-defined and established procedure for regular curriculum review.

Individuals, families, and local communities as a whole increasingly recognise that they have a real interest in their local school, as parents or grandparents, as governors, or as local employers or trades unionists. The intention of the authors of this book has been to try to capture some sense of this sometimes passionate local involvement in our comprehensive schools. However, effective support for and engagement in the concerns and preoccupations of a school does require a working knowledge of the system. The Sevenelms governors needed not just to understand how their own school functioned, but also how its concerns and priorities fitted in with those of its local authority, and how these related to national policy. This requirement is greatly enhanced under the provisions of the 1986 Education Act which gives governors specific curriculum responsibilities. This Act also increases parents' representation on governing bodies, making greater provision for co-opted governors who can reflect local views, and requires governors to report annually to parents and to listen to representations from the community about the curriculum.

As a conclusion to this book, we list below some key questions for all those who are not practising educationists but who look for ways to support and become involved in a practical and effective way in the running of their local schools. We appreciate just how much schools do need such support from their local communities. Our list is neither definitive nor complete, but we hope the questions will act as a stimulus to our readers to devise their own set of 'need to know' objectives, so that they are better able to work for the benefit of their own schools.

At national level, do you know about:

government policy on the secondary curriculum,

the relationship between central government and town or county hall funding for schools,

the involvement of other national bodies such as the Manpower Services Commission in school funding?

At local level, do you know about:

- your local authority's committee structure and which committee takes which decisions about schools,
- your local authority's policies on the school curriculum, on school staffing, and on school maintenance,
- your local authority's procedures for monitoring provision and standards in schools by means of advisers or inspectors,
- how your local authority organises its schools' administration and management: who deals with a blocked drain or the conversion of a laboratory,
- how you can obtain local authority committee minutes which record policy decisions which in turn guide the work of the administrative officers?

At school level, do you know about:

- the governors' aims for the school curriculum,
- the school's own curriculum policy,
- the school's organisation and management structure, and who takes which decisions,
- the school's committee structure for consultation and decision-making,
- how the school is financed: by whom, and at what level,
- the school's annual report which will include details of what has been done to develop links with the local community?

Glossary

Adviser: A professional officer of an education authority appointed to advise the chief education officer and teachers in the schools. Sometimes also known as a local authority inspector.

Assessment of Performance Unit (APU): A special unit within the Department of Education and Science which monitors school pupils performance in specific subject areas (i.e. English, maths and science) on a regular basis.

Association for Science Education (ASE): The specialist subject association for science teachers in schools.

Banded: Broad division of students of a particular year's intake into 2 or 3 groups (or bands) according to general ability. Within each band students can be taught either in mixed ability groups or setted (see below) according to policy.

Biological sciences: The sciences which deal with living organisms.

Capitation: The amount of money allocated by a local education authority to each school on an annual basis to cover the cost of books, equipment and other materials on a per pupil basis.

Children's Learning in Science Project (CLISP): A research project funded by the SSCR and DES to explore aspects of children's learning in science.

Circuit boards: School laboratory apparatus for teaching elementary electrical circuits.

Circus: A method of organising the timetable for a number of parallel classes so that a number of subjects or topics are taught to each group in turn. In science, a common circus approach is to offer all third year classes one term of biology, one of physics and one of chemistry in rotation, so that all have 'tasted' each science subject for one term out of the three term year.

Combined science: A science course in which the content is not differentiated into biology, chemistry and physics.

Computer assisted learning (CAL): Ways of using computers in schools either to learn information technology techniques such as computer programming, graphics or word processing, or to aid progress within particular subject areas by using computer programmes specifically designed to illustrate topics within a traditional school subject such as geography, science or French.

Content: The facts, concepts, skills and attitudes to be taught in a subject.

Continuous assessment: Assessment which continues throughout a course rather than just taking place at the end.

Co-ordinated sciences: Science subjects taught separately but with co-ordination between areas of overlap in the separate syllabuses.

Cross-disciplinary: Approaches to teaching that cross over traditional subject boundaries. For example, in science, teachers of biology and chemistry may cooperate on biochemical topics, or science staff may cooperate with teachers of English or history.

Department of Education and Science (DES): The government department responsible for education in England.

Differentiation: The ability within a course that caters for a wide range of abilities to provide for the needs of students with different levels of achievement.

Double certification: Courses that lead to two examination passes or grades.

Formative assessment: Methods of assessing a student's progress as it occurs so that teacher and student can amend what they are doing.

General Certificate of Secondary Education (GCSE): The examination for sixteen-year-olds introduced in 1986, with the first examinations to be set in 1988, to replace GCE O level and the Certificate of Secondary Education (CSE) in England, Wales and Northern Ireland.

Graded assessment: An assessment of performance or achievement made at a pre-specified level of competency rather than at the end of a course or by comparison with the performance of other students. Once a student has performed at one level, she/he moves on to the next higher level of assessment.

Health Education Council (HEC): A national body funded by the government to promote health education in and out of schools. On 1 April 1987 the HEC was absorbed into the National Health Service and renamed the Health Education Authority.

Individualised learning: Courses which enable students to work individually and proceed at their own pace.

In-service training (INSET): Professional courses of training or up-dating for teachers already in employment in schools.

Inspector: A professional appointed to advise the Secretary of State for Education who is a member of Her Majesty's Inspectorate, or a locally-

appointed official carrying out similar duties on behalf of a local education authority.

Integrated science: A science course where the usual three separate sciences are not distinguishable in themselves but where the sciences are seen as a single structure. Integrated courses can lead to a single or a double certificate at examination level.

Linnean Society: A group of people interested in the classification of animals.

Minimum entitlement: A summary of what young people might expect to gain from a particular subject or a whole set of subjects during their compulsory period of schooling.

Mixed ability group: A class or group of children of random academic abilities, i.e. not streamed.

Modular course: A course consisting of separate but not necessarily unconnected packages of work usually undertaken within a set period of time within the school year. School modules are usually measured in weeks or a term.

Nuffield course: One of a number of science courses developed through the support of the Nuffield Foundation (an education trust) to produce courses that involve a practical approach to science teaching.

Options: Subjects from which students may choose, normally in the third year of secondary education, in order to specialise for public examinations in the fifth year.

Periods/40: A school timetable divided into 40 teaching periods per week (the tables in the text indicate the number of periods per subject per week).

Physical sciences: The sciences that deal with inanimate aspects of the universe.

Problem-solving: In science, the setting of scientific and technological problems as closely related to real life as possible.

Process: Specific and specialised methods of undertaking tasks and solving problems, i.e. observing, hypothesising, experimenting and evaluating evidence in science.

Profile: An individual report which records a student's achievements over a range of school activities, not all academic, over her or his school career.

Science at Work: A scheme of work developed for below average students in the 4th and 5th years of secondary school.

School Curriculum Development Committee (SCDC): An advisory body appointed by the Secretary of State for Education to advise on and initiate reform in the school curriculum.

Secondary Science Curriculum Review (SSCR): A national curriculum development project set up with the aim of improving science education in secondary schools.

Self-assessment: The encouragement of students or teachers to assess and record their own performance in school.

Separate sciences: Science subjects, usually biology, physics and chemistry, taught as entirely separate elements of the curriculum.

Setted: Students of a particular year's intake grouped according to their ability in the subject and taught in those groups.

Single certification: Courses that lead to a single examination pass or grade.

Statement: A legally binding recommendation or statement issued by a local education authority which outlines the special provision which needs to be made for a child with special educational needs as defined by the 1981 (Warnock) Education Act.

Streamed: Students of a particular year's intake grouped according to their general ability and usually taught in those groups.

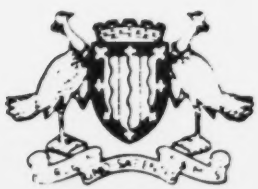
Study skills: Ways of learning how to learn.

Summative assessment: Final assessment at the end of a course.

Appendix I

Science policy statements from two local education authorities

SCHOOL SCIENCE IS CHANGING



An information leaflet for parents
prepared and published by Cambridgeshire Education Authority

SCHOOL SCIENCE

From September this year your child will follow a new coordinated science course occupying some 20% of the timetable. This course will lead to the G.C.S.E. examinations and offer the possibility of obtaining up to two certificates (passes) at G.C.S.E. The introduction of the G.C.S.E. examination system and of teaching science to all pupils in this way is Department of Education and Science policy and these changes reflect that policy. This leaflet explains why these changes have taken place and what difference it will make both at school and beyond.

Why Change?

In the past pupils have been able to choose which of the separate sciences, Physics, Chemistry or Biology, they wish to study in years four and five. As a result of this more than 9 out of 10 pupils stop studying at least one of the major sciences beyond the third year. Most pupils indeed have dropped the study of two sciences. Worst of all girls have tended to study only Biology; this closes career options which would be available to them if they had continued to study physical science. The new course enables study of elements of each of the separate sciences to continue for all pupils up to public examination level.

But my child doesn't like all of the sciences

Your child may not like aspects of English or Mathematics but we all accept that it is important to become literate and numerate. In a society that is increasingly science based and technologically orientated, scientific literacy is at least as important for all youngsters as literacy and numeracy. Study of each part of science is important to scientific literacy. In the new scheme all pupils study Physics, Chemistry and Biology together with elements of the new sciences such as Microelectronics, Biotechnology, Genetic Engineering, Space Science, and Geology.

But doesn't this devalue the single sciences?

The study of a single science has usually taken 10% of timetable time (four periods in a forty period week). You may think that putting the three sciences into a 20% time allocation would reduce the amount of study of any one science, Science however is not just a body of knowledge, facts to be learned; if it were, then a reduction in time for any one science would clearly lead to a reduction in content. Science is a blend of skills, concepts, knowledge and processes; much of this is common to all of the sciences so why repeat it in isolation in single science subjects? The new courses will build on these common foundations of science to show the contribution made by each of the single sciences.

Will these new courses lead into 'A' level work?

Yes. A double pass in science will enable your son or daughter to continue study in any or all of the three traditional sciences at 'A' level together with any of the other science based 'A' levels such as Technology, Electronic Systems and Social Biology. A single pass will enable students to continue further study in the sciences provided that teacher assessment supports this. Indeed **all** sixteen year olds will have followed a course that equips them for 'A' level

IS CHANGING

sciences, not just those that choose the right options in the third year. Students offering coordinated science courses will not be disadvantaged when it comes to applying for places on 'A' level courses.

What about the Universities?

Universities make offers to students on the basis of performance at 'A' level or B.T.E.C.. They look for evidence of breadth of study by checking performance on the G.C.S.E. Dual certificated Science meets this need. Your child's school holds a file of letters from University admissions tutors welcoming the broader science base that these new courses provide, you are welcome to read it.

But my child is not likely to go on to study 'A' levels

Of course, most youngsters choose not to stay on for 'A' levels. They enter employment, training with a Manpower Services Commission programme or study on a full time or part time basis at the technical colleges. The new courses are designed to cater for such youngsters. They not only safeguard standards for those wishing to study science further but provide a relevant, interesting and challenging science education for all pupils irrespective of their career aspirations, interests or ability.

This sounds too good to be true - is it just another educational bandwagon?

Most definitely not. Science courses leading to a double 'O' level and taking a unified view of science first appeared in 1973 and have been taught and examined ever since. Employers, Professional Bodies, Universities, Colleges, Government and Science Educators have all been consulted. The debate has taken over ten years and has led to the publication of a statement of policy from the Department of Education and Science which reflects the consensus obtained. These new courses, which have been trialled for over ten years, reflect this statement of policy.

Will these changes affect other school subjects?

It is important that pupils receive a broad and balanced education which provides essential experiences and life skills and keeps open as many career options as possible. The new science courses help this by defining the contribution that science makes. This should leave adequate time to provide courses that are creative, artistic, linguistic, recreational, mathematical, physical and for humanities and moral education.

G.H. Morris
Chief Education Officer
Cambridgeshire Education Authority

FURTHER DETAILS

In the first instance contact the Head of Science and/or the Careers teacher at your son's/daughter's school.

Courses for 16 to 19 year olds are coordinated through -

Mr. G. Thomas
Touthill Close
City Road
Peterborough

Mr. M. Dixon
Secretary to the Collegiate Board
Hobson Street
Cambridge

Area Education Offices

Mr. M.F. Cogley, S.A.E.O., Cambridge Area Education Office, Gloucester Street, Cambridge CB3 0AP.

Mr. G.J. Davey, S.A.E.O., Huntingdon Area Education Office, Gazeley House Huntingdon, Cambs PE18 6NS.

Mr. J.A.G. Jones, S.A.E.O., Northern Area Education Office, Touthill Close, Peterborough PE1 1UJ.

Cambridgeshire Careers Service

Mr. G. Willcocks, Principal Area Careers Officer, 52 Burleigh St., Cambridge.

Mr. A.L. Corder, Principal Area Careers Officer, Walden House, Huntingdon.

Mr. S. Bysshe, Principal Area Careers Officer, Touthill Close, Peterborough.

Science Inspectors

Mr. I.M. Carpenter, Senior Inspector for Science, Gloucester Street Cambridge.

Mr. M.D. Edey, Inspector for Science and Health Education, Touthill Close, Peterborough.

Chief Education Officer

Mr. G.H. Morris, Chief Education Officer, Shire Hall, Cambridge.

existing Courses must be slimmed. Without abandoning essential items. ... a reduction in overall amount of factual knowledge is unavoidable ... ... increasing support for such slimming in scientific community ...
... teaching should be related for everyday and industrial applications.
... Potentially good engineers are lost as a consequence of dropping physics in year 3 ... It is rare for pupils to return to a subject ... having dropped it in the 3rd year.
Far too few pupils follow a balanced science course ... (8% attempted examinations in all three sciences in 1980).
Science should have a place in the edu tion of all pupils ...
Every school ... give all pupils ... br science programme ...
Science for all ... should include biol chemistry, physics, Astronomy earth sciences.
Science 5-16: A statement of policy
... full weight must be given to the development of skills and processes as well as knowledge and understanding.

In March 1985 the Department of Education and Science published "Science 5 – 16: A Statement of Policy". The implications of this document are far reaching for all concerned with science education. Some of the points arising from it are set out below.

What's Wrong with the Present Science Curriculum?

It is widely accepted that the science curriculum, particularly in the years leading to examinations at 16, is dominated by the need to acquire knowledge at the expense of other qualities.

Moreover, very few boys and girls are able to study Biology, Chemistry and Physics through to examinations at 16.

By failing to study both biological and physical sciences up to the age of 16 the majority of boys and girls severely curtail their prospects in many careers or further study after 16.

What Change is Proposed?

The most significant change is to ensure that all pupils receive a **balanced Science education** up to the age of 16, incorporating substantial elements of all three major Sciences (Physics, Biology and Chemistry). This is to be done roughly within the time presently allocated to two individual subjects, so leaving room for other essential elements of the curriculum. Thus all boys and girls will have an **overall balanced curriculum** including (possibly) modern languages, aesthetic/creative subjects, and humanities with their English, Mathematics and Science.

What will it mean in the classroom?

The Secretary of State has required schools to gear their teaching to meet certain basic principles including:

- breadth and balance – ensuring that the maximum range of opportunities remain open to pupils.
- relevance – ensuring that science education draws extensively on everyday experience, setting science in its industrial and social context.
- equal opportunities – to give genuinely equal curricular opportunities to boys and girls.
- modified teaching methods – which emphasise practical investigative problem solving activities.
- assessment – which includes not only the ability to reproduce and apply scientific knowledge but also the development of skills and processes.

What skills and processes will be developed?

The policy requires that all science courses should enable pupils to be able to make observations, select relevant observations, find patterns, explain patterns, design experiments, communicate, handle equipment, investigate and solve problems.

What sort of examination qualifications will pupils be offering to employers?

From 1988 all GCE and CSE examinations will be replaced by a common GCSE examination. Grades A – C will have a standard at least as high as Grades A – C in the present 'O' level or CSE grade 1.

O-level	GCSE	CSE
A	A	
B	B	1
C	C	
D	D	2
E	E	3
	F	4
	G	5

Unsuccessful candidates will, as now, be ungraded and will not receive GCSE certificates.

Examinations in separate subjects like Physics, Chemistry, Biology, will become very much less common. In time they may disappear.

Pupils who have followed a balanced science course will have qualifications such as GCSE's in Combined Science, Integrated Science or even just Science. The certificates they receive will indicate whether the pass is a single or a double award.

What is meant by Double and Single Award?

A single award will be equivalent to one GCSE pass and indicate that Science has been studied for about 10% of the week (equivalent in time to one subject).

A double award will be equivalent to two GCSE passes indicating that Science has been studied for double the amount of time usually spent on one subject.

In either case pupils will have studied elements of all three Sciences.

Is "Single" Science easier than "Double" Science?

No. Both ensure depth and rigour; the difference is in the amount of ground covered. Students who have done "Double" Science will of course have a more extensive knowledge. Normally a pass in "Double" Science would be required for entry to advanced or further studies in Science.

What do the names Integrated Science, Combined Science mean?

These names simply describe the way that science is taught. A combined science course usually means that the elements of Physics, Chemistry and Biology have been combined into one examination with single or double award, depending on the amount of time devoted to the study.

In an Integrated Science course a particular emphasis is placed on the unifying aspects of the science studied such as pattern finding, problem solving, appreciating fundamental concepts common to all sciences, as well as learning the basic elements of Physics, Chemistry and Biology.

When will all this happen and who will be affected?

In time all pupils up to age 16 will be involved.

Some schools have already started implementing major elements of the policy. In some areas pupils have been offered Integrated Science 'O' levels for a number of years (the Schools Council Integrated Science Project SCISP) and in 1988 these will become GCSEs in Integrated Science.

Many schools will be taking the opportunity, with the introduction of GCSE, to introduce a balanced science programme.

In other areas it may take some time for these changes to occur.

Are these changes nationwide or just within Wiltshire?

The changes are nationwide since it is a national statement of policy. Different counties will respond in their own way but examinations are governed by national criteria and are taken by pupils countrywide.

Do further and higher education know about the proposed changes?

Over 60 different admissions tutors from Polytechnics and Universities throughout the United Kingdom recently replied to a questionnaire from schools concerning the acceptability of these new qualifications. Their replies indicate a most favourable response and in many cases whole-hearted approval.

All Colleges of Further Education maintained by Wiltshire County Council Education Committee have been fully informed of these changes particularly with regard to examination qualifications at 16.

The DES through the Secondary Examinations Council and other bodies is in the process of informing major national institutions.

In many cases bodies such as the Royal Society were in the forefront in demanding radical changes to ensure a balanced science education for all pupils.

If you would like any further information please write to: Chief Education Officer (Ref. CEE), Education Department, County Hall, Trowbridge, Wiltshire. BA14 8JB.

This leaflet has been prepared with the help and guidance of colleagues in British Gas, Burmah Oil, Emerson Electrical, G.E.C., Nestlé and Roussel, whose assistance is gratefully acknowledged.

CEE/CW.
February 1986.
5620E.

Appendix II:

A summary of the other publications in the Better Science series

Better Science: A Directory of Resources

Each SSCR working group, which is making material available, has submitted it to the SSCR Central Team for evaluation. Assuming that the outcomes match previously agreed objectives, each project receives a two-page entry in **Better Science: A Directory of Resources.** Each entry details the title of the materials, what form they take, the intended audience, and how the materials may be obtained. Each group provides a descriptive summary of the materials, and the Central Team provides a helpful evaluative comment. The Directory contains a systematic index, enabling materials to be located according to a variety of criteria.

Better Science: Curriculum Guides

The SSCR Curriculum Guides focus on twelve major issues. Written primarily for science teachers, they outline opportunities and problems, point to examples of good practice, and suggest strategies for tackling the issues. They are presented as a set of booklets so that individual teachers can readily focus on matters of concern to them.
The twelve titles are as follows:

Better Science: Key proposals
This Guide provides an introduction to the SSCR and its ways of working. It briefly summarises the main recommendations of the Review towards science for all young people. It also discusses the resources needed at school, LEA and national levels. The Guide provides a bibliography for use with any of the SSCR Curriculum Guides, as well as an overall index for the set of Guides.

Better Science: Choosing content
Calls for 'broad, balanced science for all' and 'process not product', along with demands to 'reduce content', make the task of deciding what to teach in school science complex. This discussion document considers many of the claims on science and offers some solutions and exemplars in the light of work by SSCR groups.

Better Science: Making it relevant to young people
This Guide examines how school science can be made more pertinent to youngsters' thinking and everyday living. It considers ways in which the process of applying science can be taught. It also considers the role of technology studies in the science curriculum.

Better Science: Approaches to teaching and learning
This report is written by experienced practising teachers and describes, through the use of case studies, ways in which a broad range of approaches to teaching and learning can be used to enhance students' learning in science successfully.

Better Science: How to plan and manage the curriculum
As a help for teachers engaged in planning for broad and balanced science courses, this Guide addresses timetabling, organising the subject matter, programming the learning, modular approaches and alternative contexts for science education.

Better Science: For both girls and boys
This is a summary of the main findings of recent research projects into the responses of girls to physical science, which also have implications for boys. Practical suggestions are provided for teachers to enable them to address the problem for themselves.

Better Science: Working for a multicultural society
Here the focus is on a relatively new item on the agenda of science educators. The Guide uses a series of articles to raise particular issues and provides practical examples of curriculum development work to date. The message of this Guide should inform the practice in all science departments.

Better Science: For young people with special educational needs
This Guide reflects the importance of improving provision of science education for children with learning difficulties. It is set in the context of special education, which has seen major changes since the publication of the Warnock Report. The emphasis is on identifying and responding to individual needs.

Better Science: Health and science education
The concern here is with what is understood by health and health education. Where, when and how does health education take place in the science curriculum? Who teaches it and how can teachers assess and evaluate it? The Guide uses case studies in most sections to show how science teachers working with the Review have implemented many of the suggestions and recommendations made.

Better Science: Building primary–secondary links
The Guide surveys the kind of science which goes on in primary schools. It assesses the skills which good primary science gives children by the age of transfer to secondary school, and goes on to consider how secondary schools build on this.

Better Science: Assessing progress
In this Guide the key issues of assessment are discussed and up-dated in response to developments both inside and outside the Review. It is set in the context of the Review's belief in the need to change the emphasis to formative, criterion-referenced assessment.

Better Science: Learning how to teach it
This Guide illustrates how the process of learning how to teach better science has three stages. The first stage begins formally with initial training. Training then continues through the induction period. Finally, training should be consolidated through a regular in-service programme. Having read this Guide, teachers should have a clear idea how to operate successfully in the system.

When it was established in 1981 the aim of the Secondary Science Curriculum Review (SSCR) was to stimulate, through working groups of practising teachers, the development of science studies which would help to provide an appropriate science education for *all* young people growing up in a scientific and technological society — whatever their abilities or career intentions. Its concern was not only with the science curriculum — its content, purposes, teaching methods and resources — but also with the role of science in general education and within the whole school. The SSCR roused a great deal of interest and support throughout the science education community and the success of its development programme led to a three-year extension for dissemination which started in September 1986.

Better Science: Making it happen seeks to show science education in the context of the whole school curriculum. It describes how the staff of a typical science department, in a typical comprehensive school, become dissatisfied with their work and seek to change their whole approach to science teaching. Understandably, it soon becomes apparent that the proposed changes will affect not only the science department but also the rest of the school and, indeed, the community of which the school is a part. It will be of interest to parents, governors, head teachers, administrators, local education authority officers, industrialists, science and other teachers — in short, to everybody concerned with or for the whole school community.

ISBN 0 435 54822 0

Also available:

Better Science: A Directory of Resources contains details of a broad range of materials produced by local working groups and the Review's Central Team. It includes descriptive and evaluative statements on each piece of material listed.

Better Science: Curriculum Guides deal with significant areas of concern and aim to assist teachers in devising a broader and more balanced approach to science studies and in enhancing their own professional development. The Guides are available as a set of twelve as follows:

1 Better Science: Key proposals
2 Better Science: Choosing content
3 Better Science: Making it relevant to young people
4 Better Science: Approaches to teaching and learning
5 Better Science: How to plan and manage the curriculum
6 Better Science: For both girls and boys
7 Better Science: Working for a multicultural society
8 Better Science: For young people with special educational needs
9 Better Science: Health and science education
10 Better Science: Building primary–secondary links
11 Better Science: Assessing progress
12 Better Science: Learning how to teach it

Heinemann Educational Books / Association for Science Education for the School Curriculum Development Committee